THE Petroleum Engineer

FEBRUARY 1935

VOLUME VI NUMBER V

A MAGAZINE OF METHODS FOR OPERATING MEN

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Petroleum Industry Electrical Association—April 11, 12 and 13, Baker Hotel, Dallas, Texas.

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Natural Gasoline Association of America—May 1, 2 and 3, Tulsa Hotel, Tulsa, Oklahoma.

American Petroleum Institute, Fifth Mid-Year Meeting—May 14, 15 and 16, Mayo Hotel, Tulsa, Oklahoma.

Pennsylvania Grade Crude Oil Association, Annual Meeting — June 20 and 21, State College, Pennsylvania.

American Society for Testing Materials, Annual Meeting—June 24, 25, 26, 27 and 28, Book Cadillac Hotel, Detroit, Michigan.

American Petroleum Institute, Sixteenth Annual Meeting—November 11, 12, 13, and 14, Biltmore Hotel, Los Angeles, California.

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SUBSCRIPTION PRICE—Single copies 15 cents. Domestic and foreign, $1.00 per year, three years $2.00, with the exception of Canada, where the price is $1.65 per year, three years $3.95.

THE PETROLEUM ENGINEER PUBLISHING COMPANY

Tower Petroleum Building

DALLAS, TEXAS

NEW YORK CITY

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Vice-President
101 Capitolian Blvd.
Rockville Center
Long Island, N. Y.

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LOS ANGELES, CALIF.

C. MORRIS
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The Course of Oil

By K. C. SCLATER

Mr. Ickes Expresses His Views

In an article, "After the Oil Deluge, What Price Gasoline?," in the Saturday Evening Post of February 16, Mr. Ickes upbraids the American oil industry and says that in his opinion, "if the oil industry cannot control its affairs in the public interest, then the Federal Government, of necessity and to protect all the people, must take a hand." The indictment implied in this statement is not warranted by the facts, for the industry has always up to now lacked the necessary power to control its affairs in the public interest. Despite this impotence, the industry has made progress in conducting its own affairs and in contributing to the general public welfare. The evidence is not far to seek; for example, today, two gallons of gasoline are obtained from a unit volume of crude oil from which only one would have been obtained seventeen years ago. Manufacturing costs have also been reduced and the savings passed on to the public.

Commenting on the charting of a course for the industry to follow, Mr. Ickes takes occasion to impugn the motives of sincere advocates of a state compact, which compact at this writing has just been signed by nine of the oil-producing states. Palpably, Mr. Ickes has his facts twisted when he says: "It (a state compact) has been tried without success." Any constructive suggestions Mr. Ickes has to offer the industry can only be viewed with caution when such misstatements of facts are made.

The president of the American Petroleum Institute, Axtell J. Byles, in taking issue with the views expressed by Mr. Ickes, says: "The Secretary makes an attack upon the good faith of the entire American petroleum industry, condemning it in sweeping generalities and ignoring its great contribution to the progress of the country. It is equivalent to showing but one side of a balance sheet—failing to disclose the assets and dramatizing the liabilities.

"The industry admits faults common to rapid growth, but feels that it has rendered a unique service to the American people. It has aided the unparalleled development of automotive transportation to which the public owes so much. No person has been charged unreasonable prices or in any way handicapped in his utilization and enjoyment of the products of petroleum. The industry is today meeting the gasoline requirements of the nation out of half the volume of crude oil which would have been necessary to meet such requirements seventeen years ago. To have produced last year's gasoline requirements by the processes in use in 1917 it would have been necessary to have run 1,866,000,000 barrels of crude oil. In 1934 the industry actually supplied the gasoline requirements by running 893,000,000 barrels of crude oil. That is real conservation of a limited natural resource.

"The retail price per gallon at which this gasoline was sold to the public in 1934 was just half the retail price per gallon which it was necessary to charge fifteen years ago. This reduction in cost to the consumer, made possible by increased efficiency on the part of the industry, was largely defeated by cumulative federal, state, county, and municipal taxes which on gasoline and motor lubricants alone amounted to over $754,000,000 last year.

"There has been some waste incidental to the production of crude petroleum, particularly in the earlier stages of development, but such waste has been mainly due to the law of capture which was imposed upon the industry by the courts. This constitutes a fundamental problem which representative members of the industry long have struggled to eradicate, developing proration and unit operation as partial correctives. Certainly, the oil industry cannot justly be charged with the appalling gas waste in the Panhandle field or failure to enforce proration in East Texas."

Mr. Byles said he did not agree with the Secretary's views concerning the futility of an interstate compact, and expressed serious doubt as to the legality of remedies proposed by the Secretary. He added:

"Federal control of the oil business offers nothing that the industry, with the aid of states wherein crude oil production lies, cannot itself more effectively provide. One of the most constructive things that the Federal Government could do is to re-enact, in constitutional form, a prohibition against transportation in interstate and foreign commerce of crude oil and its products produced in violation of state laws. Regimentation from Washington would stifle the far-flung individual activities necessary to sustain this dynamic enterprise and, in the long run, would lead to the creation of a shortage of and so high a price for motor fuel that it would work injury to the American public. It is impossible to operate the petroleum industry as a public utility and threats to attempt to do so may delay progress toward the consummation of those things which both the Secretary and the industry desire to attain in the public interest."

Potential System Discarded

One state at least sees fit to throw into the discard the "potential" system of prorating wells and in its stead adopt a more rational method of allocating well allowables.

What the State of Michigan is seeking to do is to allocate the production of each well on what has been termed a normal producing basis; that is, its average ability to produce day after day over an extended period.

Under the "potential" system there has arisen a mistaken belief that tremendous amounts of oil are immediately available for market. Potentials are without a doubt the grand inhibition of the oil industry.

It is heartening to observe, therefore, that this enlightened step to banish the spectre called "potential" has been taken.

« « « HIGHLIGHTS IN OILDOM » » »

House Committee Revises Connally Bill

After holding up for several days its report on the Connally oil bill, designed to take the place of Section 9-C of the Recovery Act, declared unconstitutional, the House Interstate Commerce Committee has finally agreed upon a compromise measure. From the Connally bill, which passed the Senate, has been eliminated all but one paragraph and new provisions substituted. These provisions are described as being less stringent federal control than those in the original Connally bill.

The committee bill merely would direct the President to forbid interstate transportation of oil and its products produced or withdrawn from storage in excess of quotas fixed by state laws or agencies whenever he found excess oil was an undue burden on interstate commerce by reason of causing a lack of parity between supply and demand. The Connally bill would forbid outright the interstate movement of oil and derivatives produced, processed, or handled in excess of amounts stipulated by the states.

The committee eliminated the sections of the Connally bill that would provide for certificates of clearance for oil moved in interstate commerce, and for the setting up of boards to issue the certificates for legal oil. Chairman Rayburn of the Interstate and Foreign Commerce Committee stated, however, that a subcommittee headed by Representative Cole of Maryland has been directed to draft clauses covering administration of the measure.

The House committee also added a proviso limiting the life of the legislation to June 1, 1936, and another that would permit the government to confiscate illegal oil flowing in interstate trade.

The paragraph of the Connally bill retained was that declaring it to be the policy of Congress to protect interstate and foreign commerce from the harmful effects of contraband oil. This was designed to meet the Supreme Court decision that Section 9-C of the Recovery Act, authorizing the President to prohibit interstate and foreign commerce in illegal oil, is unconstitutional on the grounds that it was an unwarranted delegation of the powers of Congress to the executive.

●

Six-Hour Flow Tests for O. C.

A six-hour open flow test with the last four hours to count will be the method employed to determine potentials for wells of the Wilcox zone of the Oklahoma City field for the six-months' period beginning with April, the state corporation commission has decided. The result multiplied by six would give the daily potential.

A hearing was held recently on application of the Indian Territory Illuminating Oil Company and other companies for determination of a method for taking open flow potential tests.

●

Third Oil States Conference

At the request of Governor James V. Allred of Texas, Governor Marland of Oklahoma has called a third oil-states conference, this one to meet in Dallas February 15. The purpose of this meeting is the same as the others: to consider a compact among the oil-producing states. An effort will be made to effect an agreement of the principal oil states on legislation to control production, and other controversial matters in the industry. The first conference accomplished little; at the second, the oil-states' compact proposal, providing for a board to set allowables, was adopted.

Water in Conroe Field

The water problem in the Conroe field, Texas, is becoming more serious, according to information from reliable sources, and at present there are 57 wells in the field averaging from 1 to 65 per cent water. Two wells have been abandoned because of water and several others are dead. Most such wells are around the edges or along the fault planes of the field.

●

Ask Higher Oil Import Tax

Representative Morgan Sanders of Texas has introduced into the United States House of Representatives a bill to increase the import tax on crude petroleum to 42 cents a barrel. The present import duty of 21 cents a bbl. expires in June. At the same time the petroleum code, which includes a limitation upon imports, dies, and fear has been expressed that unless adequate legislation is enacted prior to that date the country may be flooded with foreign oil.

Sanders' bill also includes a $2 per ton import duty on asphalt.

The measure has been referred to the Ways and Means Committee, of which Sanders is a member.

●

Disney Drafts Oil Legislation

Representative Wesley E. Disney of Tulsa, Oklahoma, has placed before President Roosevelt the first draft of new legislation providing for federal enforcement of oil production allocations in the three states having state proration laws. President Roosevelt had asked Representative Disney to prepare a bill on oil legislation. The bill will not be introduced into the Congress unless it is approved by the administration, it is stated.

The Disney measure sets up a board of five members to determine national supply and demand and allocate production quotas to the three states having state laws providing for proration of production between the various producing fields. The Secretary of Interior is made a fifth and ex-officio member of the board. The others would be named by the President. The board would have no authority to impose its production allocations upon a state unless that state, already having proration laws, refused to maintain its allowable as determined by the board, Disney explained.

No expiration date is fixed in the Disney bill, thus, if enacted, it would become a permanent statute. Disney says the bill does not attempt to set up federal control over the industry. Rather, he terms it a measure for protection of the states against uncontrolled production of competing states, and lawless and reckless exploitation of production within a state.

●

U. S. Held Owner Elk Hills Oil

The Elk Hills oil reserve in California, involved in the famous Teapot Dome case, belongs to the United States government, Secretary of Interior Ickes has ruled. The decision opens the way for government suits to recover $25,000,000 for oil taken from the reserve in recent years by various private concerns. This decision also settles the last aspects of the Teapot Dome-Elk Hills case.

Ickes reversed a ruling made February 23, 1933, by Federal Land Office Commissioner C. C. Moore, who upheld the right of California to hold title under a school land grant of 1903. Ickes' decision hinged on whether the mineral character of Elk Hills was known in 1903 when section 36 was transferred to title of California. He decided that they were, and held that California had never held legal title to the land, therefore could not transfer or lease it.

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"OILWELL"

LATEST ACTIVITIES IN THE OIL FIELDS

THE bringing in early in the month of Harvey Blair and Willis Hartman well No. 1 Theodore M. Gurney, four and a half miles southeast of Russell, Kansas, opens a new pool along the Barton Arch, the thirteenth for Russell County. The well was drilled to a total depth of 3006 ft. and is producing from the Oswald lime. On the initial test it swabbed 15 bbl. an hour and later was cleaned out and acidized.

The Shell Petroleum Corporation's No. 3 A. P. Haury, half way between the Allen and Manvel pools, apparently has given Brazoria County, Texas, its eighth pool. On the initial flow the well produced 1,000,000 cu. ft. of gas and four bbl. of oil daily through a ⅜-in. choke. The test was drilled to a depth of 7495 ft., but was plugged back and completed at 7237 feet.

The Monument area of Lea County, New Mexico, is attracting the attention of oil men. The Amerada Petroleum Corporation has had several showings on its prospect well No. D-1 State. Oil and mud was picked up in a drill-stem test at 3804-3858 ft., after which the hole was deepened to 3898 ft. for another test. This well has had volumes of gas totaling from 1,000,000 to 7,000,000 ft. daily from 2600 ft. down.

The discovery of a new pool in Fisher County, Texas, seemed apparent when the Merry Brothers and Perini and the Tide Water Oil Company's test No. 1 E. Howard flowed three heads of oil, one lasting 30 minutes and producing 40 bbl., before being put on the swab. The oil tests 38.8 gravity. The well is 12 miles west of the north end of the Royston area and is drilled to an approximate total depth of 3670 feet.

A test that seems assured of opening a new productive area in California is the Universal Consolidated Oil Company's No. 1 Nutt, east of the Montebello field. A recent drill stem test indicated a well that will produce approximately 1000 bbl. daily. At a depth of 5122 ft. the operators were preparing to make a production test.

A deeper drilling campaign apparently is getting underway in West Virginia. At the present time six tests are drilling in the Cooper's Creek district of Kanawha County with others expected to follow and if these prove successful it may be the beginning of a deeper drilling campaign throughout the state. The success of Fred Paul Grosscup and his associates in finding production last summer at 4800 ft. encourages the redrilling, at a greater depth, of many old fields in the state.

Dirk Brothers' No. 1 Foley, four miles southwest of the West Tuleta pool in Bee County, Texas, tested 400 ft. of oil in 12½ minutes in sand at 3409-3427 ft., and if brought in as a commercial producer will open a new pool, the third Dirk Brothers have discovered in northern Bee County in less than a year.

The Sinclair-Prairie Oil Company et al's No. 1 School Land, a wildcat test nine miles northeast of Guthrie and four miles southeast of the Langston pool in eastern Logan County, Oklahoma, has opened a new pool. Initial tests indicated a 100- to 150-bbl. well. The well was drilled to below 5000 feet.

A new Arbuckle lime pool has been discovered in Osage County, Oklahoma. The Bay Oil Corporation's No. 1 Osage initially flowed 225 bbl. of oil in 23 hr. from a total depth of 2911 feet. The well is three and a half miles northwest of Cleveland.

The Humble Oil and Refining Company's No. 3 Devilbiss, one mile southwest of the discovery well in the Roanoke field of Louisiana, is the deepest producing well in the Gulf Coast district and opens a new producing sand. It was brought in recently making 3,000,000 cu. ft. of gas and some oil at a total depth of 9425 feet. The hole was drilled to a depth of 9571 ft. but was plugged back.

AVERAGE CRUDE OIL PRICES

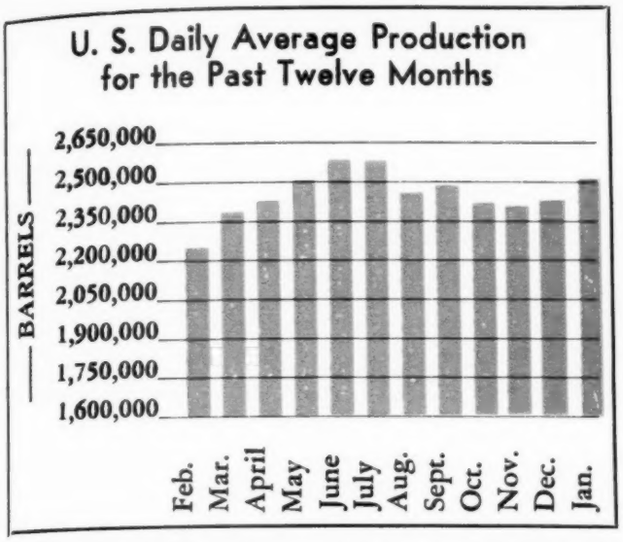
California		Louisiana	
Playa Del Rey	$ .90	North Louisiana	$ .95
Coalinga	.81	Gulf Coast	1.04
Signal Hill	1.12	Illinois	1.13
Montana	1.35	Kentucky	1.08
Wyoming	1.00	Indiana	1.12
Colorado	1.00	Ohio	
New Mexico	.75	Lima	1.30
Texas		Michigan	1.02
North Central	.95	Pennsylvania	
Panhandle	.83	Bradford	2.20
West Texas	.70-.75	Southwest	1.87
Gulf Coast	1.04	Eureka	1.82
Darst Creek	.87	Buckeye	1.72
East Texas	1.00	Corning	1.32
Kansas	1.00	West Virginia	1.67
Oklahoma	1.00	Canada	2.10-2.17
Arkansas	.70		

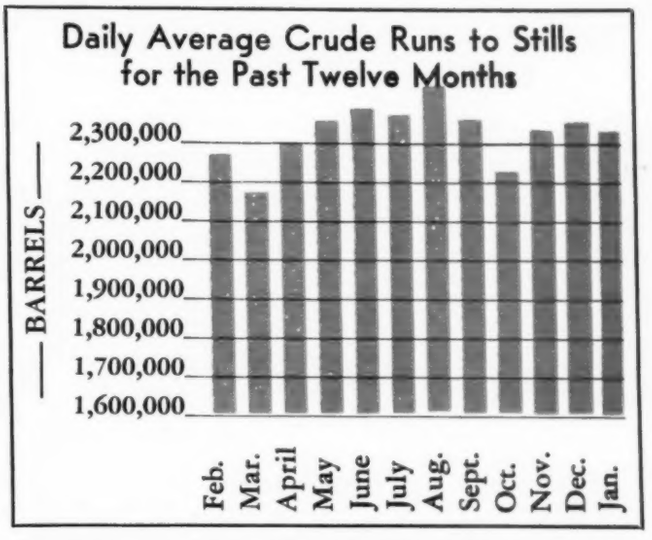
DAILY AVERAGE CRUDE OIL PRODUCTION

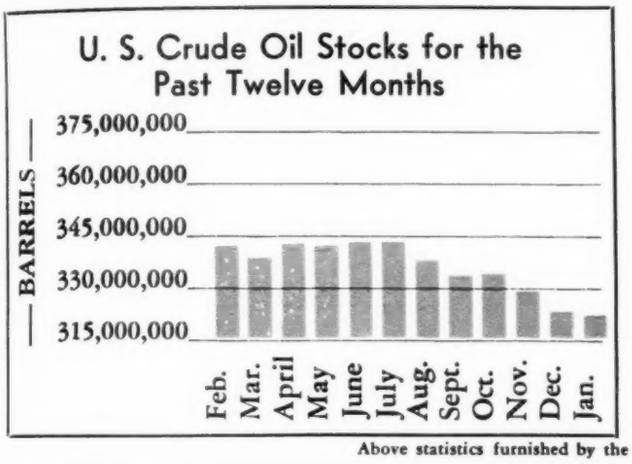
(Figures in barrels)

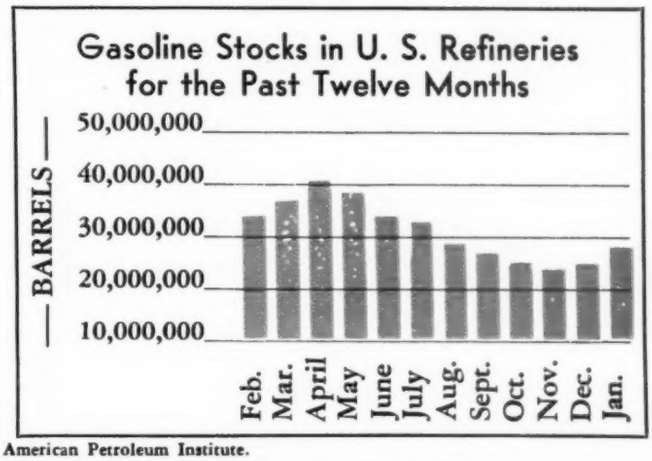
Furnished by A.P.I.

	Federal Agency Allowable Effective Dec. 17	Week Ended Jan. 26, 1935	Week Ended Dec. 29, 1934	Week Ended Jan. 27, 1934
Oklahoma	489,300	509,950	469,200	467,350
Kansas	137,100	141,000	142,750	107,450
Panhandle Texas		60,900	61,150	42,600
North Texas		56,750	57,550	52,900
West Central Texas		26,050	26,400	24,750
West Texas		153,950	155,800	129,250
East Central Texas		51,500	46,400	42,950
East Texas		427,800	419,400	396,000
Conroe		47,600	46,150	47,700
Southwest Texas		57,850	54,650	44,050
Coastal Texas (Not incl. Conroe)		127,900	130,000	110,750
TOTAL TEXAS	1,006,800	1,010,300	997,500	890,950
North Louisiana		23,200	23,900	27,800
Coastal Louisiana		88,550	85,400	45,700
TOTAL LOUISIANA	99,700	111,750	109,300	73,500
Arkansas	31,000	31,400	34,300	32,100
Eastern (Not incl. Michigan)	96,100	99,400	98,550	98,600
Michigan	28,100	34,650	27,700	23,550
Wyoming	35,700	33,200	35,050	29,650
Montana	9,300	11,950	12,050	5,350
Colorado	3,500	3,850	3,150	2,850
TOTAL RK. MT. ST.	48,500	49,000	50,250	37,850
New Mexico	49,800	48,050	44,850	41,500
California	473,900	506,600	466,300	449,900
TOTAL U. S.	2,460,300	2,542,100	2,440,700	2,222,750









Above statistics furnished by the American Petroleum Institute.

Summarized Operations in Active Fields for January, 1935

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas								
East Texas	264	262	111	171	3600	2	40	Rotary
Duval County	25	18	3	9	2300	2	22	Rotary
Archer County	66	41	19	38	660–1800	1 or 2	40	Rot.-Cab.
Conroe	3	3	1	3	2000–7400	3 or 4	40	Rotary
Refugio County	7	6	3	5	5200	2	38	Rotary
Oklahoma								
Oklahoma City	4	4	8	20	6500	3	39	Rotary
Osage County	23	18	20	48	380–2850	2	37.5–40	Rot.-Cab.
Kansas								
McPherson County	12	8	5	28	2900–4300	2	38	Rot.-Cab.
Ellsworth Arch	41	34	22	101	3300	4	37	Rot.-Cab
California								
Kettleman Hills	3	3	2	24	8300	3 or 4	40	Rotary
Long Beach	8	8	10	34	7000	3	36	Rotary

Field Activities by States for January, 1935

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1934 (In Barrels)
	January	December	January	December	January	December	January	December	January	December	
Arkansas	20	14	11	5	22	21	10	17	53	42	11,412,100
California	47	44	45	39	45	79	65	81	212	226	175,678,362
Colorado	1	2	1	1	....	....	4	5	24	26	1,168,000
Illinois	3	3	2	1	....	....	1	11	18	9	4,466,000
Indiana	6	12	4	9	....	....	2	2	54	52	813,000
Kansas	86	66	63	47	129	88	44	42	233	192	45,577,050
Kentucky	13	15	9	9	....	....	1	2	19	22	4,863,000
Louisiana	60	64	33	41	59	48	50	54	134	151	32,572,900
Michigan	28	26	21	17	48	42	132	103	149	169	10,589,600
Mississippi	3	4	0	1	....	....	1	2	11	13	Gas Prod.
Montana	8	10	4	10	....	....	9	7	44	46	3,797,000
New Mexico	15	19	10	15	....	....	14	9	88	79	16,529,050
New York	....	....	....	....	....	....	1	1	2	3	2,880,700
Ohio	117	124	83	81	....	....	52	51	214	211	4,291,000
Oklahoma	139	148	92	84	180	169	93	103	494	462	176,506,550
Pennsylvania	17	12	14	10	....	....	16	22	86	89	15,353,850
Texas	768	746	561	571	954	1061	407	447	1019	1107	380,848,000
West Virginia	30	55	24	43	....	....	18	23	80	89	4,043,550
Wyoming	1	3	1	3	....	....	8	9	68	74	12,371,100
Total	1362	1367	978	987	1437	1508	928	980	3002	3088	903,850,812

PROGRESS OF MAJOR PIPE LINE WORK

PLANS are under way for the construction of a gas pipe line from the Texas Panhandle to St. Louis and Detroit, Public Works Administrator Harold L. Ickes announced recently. The project would cost between $30,000,000 and $50,000,000 and would take the excess gas from the Texas Panhandle that is now being wasted at the rate of one billion cu. ft. daily. The project would be administered by the State of Texas, and Ickes revealed that he has conferred recently with R. B. Anderson, personal representative of Governor James V. Allred of Texas. The project would be financed by PWA funds.

If separate lines were run from Texas to St. Louis and Detroit a total expenditure of $50,000,000 would be involved, but if a single line is laid to Detroit via St. Louis the cost would be $30,000,000.

●

The Sinclair Pipe Line Company is reconditioning parts of its line between Shawnee and Pauls Valley, Oklahoma, a distance of 45 miles. The line is an 8-in. and 12-in. one, and spot welding and patching are being done where the pipe is found to be badly corroded.

●

An outlet has been provided for the Bruni townsite area of the Cole field in Webb County, Texas. The American Liberty Oil Company and the Humble Pipe Line Company have reached an agreement whereby the American Liberty has leased two 55,000-bbl. tanks at the Humble's Bruni tank farm and has constructed a pipe line from the field to the latter point. The Humble is to transport the crude from there to Inglesides for coastwise transportation by water.

●

The Stanolind Pipe Line Company has completed the 15-mile pipe line, consisting of eight miles of 8-in. and seven miles of 4-in. pipe, from the Gates pool in Stafford County, Kansas, to the company's Hudson station in the same county. This is a part of an extensive construction program that the Stanolind has under way in Kansas at the present time. Included in the program is the laying of 65 miles of 10-in. pipe paralleling an existing line. Twenty miles of this is from Eldorado east to Sallyards junction, 20 miles is on the line west of Eldorado in Sedgwick County, and 25 miles is in Stafford County, southeast of the town of Stafford. Forty miles of the pipe is new, the remainder being reconditioned pipe taken from various portions of the company's system. The Stanolind's line also is being looped from its Brandenstein booster station in Rice County to the Smokey Hill River junction in Russell County, a distance of 29½ miles. From the Brandenstein station to the Bushton station, 7½ miles, the existing 6-in. line is being paralleled with an 8-in. line, while from Bushton to the Smokey Hill River junction a 6-in. line is being laid to parallel the present 6-in. line.

The Firm Oil Company has constructed a 2½-in. pipe line from its new producer in northern Bee County, Texas, to Pettus, Texas, a distance of approximately ten miles, and built a loading rack. The same company is to lay a second line, a 4-in., paralleling the 2½-in. line, as soon as more production is developed, they announce. The well here referred to is the Firm Oil Company's Grissom, brought in a producer recently, and is looked upon as having opened a new field.

●

The Coletto Creek field, Victoria County, Texas, has taken on increased importance with an outlet provided for its crude. Albert Plummer, who is an extensive operator in the field, has constructed a gathering system and laid a 4-in. line to Aloe, where he also has provided loading racks. Prior to the laying of the line there were 20,000 bbl. of crude accumulated in lease storage.

●

The Gulf Pipe Line Company is laying a pipe line from the Gypsy Oil Company's discovery well in the Altus district to Humphreys, Oklahoma, where a loading rack will be constructed. From Humphreys crude from the new Altus field will be transported by tank car to Wichita Falls, Texas, and turned into the Gulf's trunk line. This is the first outlet for the district.

●

A new marine terminal is to be built at Houston, Texas, by the General American Transportation Corporation, and the company's terminal at Carteret, New Jersey, will be enlarged to twice its present capacity. The Houston terminal will have direct pipe line connections with the East Texas field, it is announced. It will cover 50 acres in the Galena Park section with frontages on the Houston Ship Channel and the Southern Pacific Railroad. The first unit, expected to be completed between March 15 and April 1, will have a total capacity of 500,000 bbl., and additional units may be added later in the year. Buildings will include a modern office structure, a testing laboratory, residences for department heads, and a car repair shop. The terminal at Carteret, New Jersey, opposite Staten Island, now has 500,000 bbl. capacity, which will be increased to 900,000 barrels. Construction work will start soon. New tanks, recently completed at the Corpus Christi, Texas, terminal, increase its capacity to 600,000 barrels.

●

Construction of a 20-mile gas pipe line by the Southern Ontario Gas Company from Leamington, Ontario, to the Glenwood field is scheduled to commence early in the spring, with the line completed early in the summer. The town of Leamington handles local distribution through its own mains and heretofore has been supplied with unpurified gas. Under an agreement with the Southern Ontario Gas Company that company will deliver purified gas.

THE MONTH'S ACTIVITIES IN REFINING

Per Cent Refining Capacity Operated

Eastern Division, 70.6 per cent | Central Division, 65.0 per cent | Western Division, 60.4 per cent

THE Phillips Petroleum Company is enlarging its Okla and Vinita Park natural gasoline plants in the Oklahoma City field. Materials already have been purchased and five 230-hp. compressors are being installed at each plant, giving Vinita Park 30 units of that size and Okla ten. The engine rooms of both plants are being extended 75 feet.

●

The Crown Central Petroleum Corporation at Houston, Texas, has let a contract for a large steam generator, which will be tied into the present boiler house. The new unit is being supplied by The Henry Vogt Company, Louisville, Kentucky, and is of the new all-welded construction designed for 75,000 lb. of steam per hour.

●

George L. Machris, president of the Wilshire Oil Company, Inc., of California, has signed a license contract with the Universal Oil Products Company, Chicago, for a combination skimming and Dubbs cracking unit to process 12,000 bbl. of crude a day. The unit, a refinery in itself, is to be constructed at Santa Fe Springs, California. Present plans call for the unit to take off a 35 per cent cut with waste heat by means of a system of heat exchangers and to subject the topped crude, amounting to approximately 7800 bbl. daily, to selective cracking. It will operate on the full-flashing principle.

●

The Westgate Oil Company is enlarging its gasoline plant in the Oklahoma City field with the installation of five new 230-hp. compressor units, purchased from Clark Bros. Co., Olean, New York.

●

The Sabine Gasoline Company has started construction near Longview, Texas, of what is reputed to be the largest gasoline plant in the East Texas field. The gas is to be taken from more than 1000 wells having an approximate volume of 14,000,000 cu. ft. per 24 hours. The plant is of the vapor rectification type patented by Petroleum Engineering, Inc., which company is furnishing both equipment and engineering. The plant will cost $550,000 and is expected to be placed in operation by May 1.

●

Fred Bowen has obtained a surface lease on two acres of the Willis Smith and others' No. 1 land in the J. S. Caruthers survey of the East Texas field, upon which he proposes to construct a natural gasoline plant.

●

The 1500-bbl. refinery being constructed by the McClanahan Refining Company at St. Louis, Michigan, ten miles west of the Porter pool, is scheduled for completion February 15, E. G. Guy, in charge of construction, has announced. D. E. Foster will be superintendent of the plant, which will provide an outlet for the McClanahan Oil Company.

●

The United Gas Public Service Company has announced plans for doubling the capacity of its 20,000-gal. gasoline absorption plant in the Rodessa gas field in north Caddo Parish, Louisiana.

●

Capacity of the recently-constructed refinery of the Fern Oil Company at Thermopolis, Wyoming, is being increased from 2500 bbl. daily to 7500 barrels. New refining units and three new 100-hp. boilers are being installed.

●

The Apex Gasoline Company has placed in operation its new casinghead gasoline plant in the Porter field of Midland County, Michigan. From 2,000,000 to 3,000,000 cu. ft. of gas is being used daily and eventually it is expected to increase that volume to 5,000,000 cu. feet.

●

The Arkansas Natural Gas Corporation has purchased the contracts and gathering system of the Phillips Petroleum Company in the Homer field of Louisiana. These contracts will make it possible for the Arkansas Natural to double its daily output of natural gasoline in the field. The Phillips plant will be dismantled and moved to Oklahoma.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending January 26, 1935

A. P. I. Figures

(Figures in Barrels of 42 Gallons Each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	417,000	71.6	13,281	11,551
Appalachian	93.3	89,000	63.6	2,004	1,212
Ind., Ill., Ky.	94.6	323,000	76.5	8,159	4,761
Okla., Kans., Mo.	83.7	246,000	63.7	4,793	4,004
Inland Texas	47.6	90,000	53.9	1,288	1,813
Texas Gulf	97.7	478,000	81.4	5,727	9,477
La. Gulf	96.4	120,000	74.1	1,215	4,135
No. Louisiana-Ark.	83.7	40,000	51.9	250	477
Rocky Mountain	66.7	42,000	65.6	737	736
California	96.9	454,000	55.2	10,434	65,845
TOTALS WEEK:					
January 26, 1935	89.8	2,299,000	67.4	47,888	104,011
January 19, 1935	89.8	2,347,000	68.8	46,995	106,034

Chopping Down THE HIGH COSTS OF ROTARY POWER

THIS kind of Diesel-electric power quickly pays for itself on any location where water is scarce or where natural gas is limited or not available. Draw works, rotary table, mud pumps — all can be driven safely, smoothly, dependably, and at minimum expense.

One company has been using a pair of Cooper-Bessemer Diesels for Diesel-electric drilling, similar to the one illustrated, for more than four years.

Cooper-Bessemer engineers have made a most intensive study of the operating characteristics of Diesel A. C. and D. C. drives, also Diesel direct drives. The very latest records are available to you.

THE COOPER-BESSEMER CORPORATION

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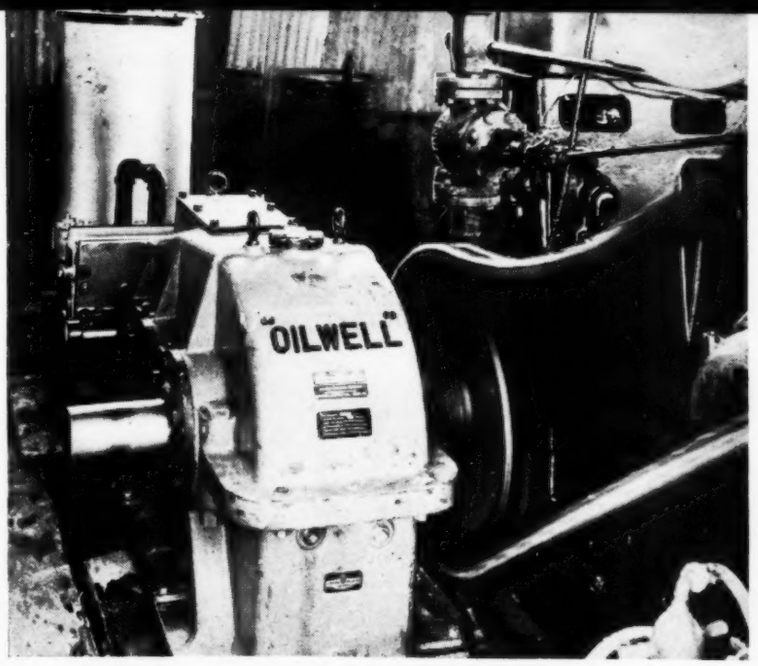
640 East 61st Street, Los Angeles, Calif — 201 East First Street, Tulsa, Oklahoma — Magnolia Building, Dallas, Texas — 25 West 43rd Street, New York City — 225 Crockett Street, Shreveport, La. — 505 Esperson Building, Houston, Texas

A Cooper-Bessemer 300 H. P. Type FP six-cylinder Diesel engine with atmospheric relief injection system, radiator and direct-current generator, all mounted portably on sub-base for Diesel-electric drilling



Rotary Feed Control in service on well in Kettleman Hills field, California

NEW ROTARY FEED CONTROL

Compact unit, deriving its power from tension in drilling line, holds uniform rate of feed on bit

CLOSE regulation of the weight on the bit is a vital requirement contributing to efficiency in rotary drilling operations. The greater the drilling depth and the heavier the equipment used the more important does this requirement become. If the desired weight on the bit for the formation being drilled is to be held at a constant value, it is essential that the rate at which the bit is fed be positively uniform.

With the regular type of heavy-duty rig, the conventional hand-feeding method in universal use for feeding the bit is a purely manual operation and as such, the degree of control exercised may be subject to wide variations, being dependent wholly on the alertness and skill of the driller. Using the weight indicator as a guide, he controls the weight to the best of his ability by manual pressure on the brake lever of the hoisting drum. Irregularities in the rate of feed under such conditions are inevitable; but the detrimental effect on drilling efficiency is difficult to estimate. It is certain that maximum bit performance is not obtained. There are also the twist-off hazard and the possibility of a crooked hole to be considered.

An entirely new type of rotary feed control has recently been developed that is designed to overcome the inadequacies and hazards of hand-feeding methods. This new device was tested out about a year ago in the Kettleman Hills field, California, on a heavy-duty rotary drilling rig of the Drilling and Exploration Company. The president of this company, J. E. Brantly, is the inventor and patentee of the new feed control.

Soon after the feed control had been put into use it became apparent that the efficiency of the rig had been greatly increased and that the feed control made it possible to drill straight holes with minimum effort and expense. Its successful performance led to the development of the "Oilwell" Brantly Rotary Feed Control, now used extensively for deep drilling and for drilling where the vertical deviation must be held within close limits.

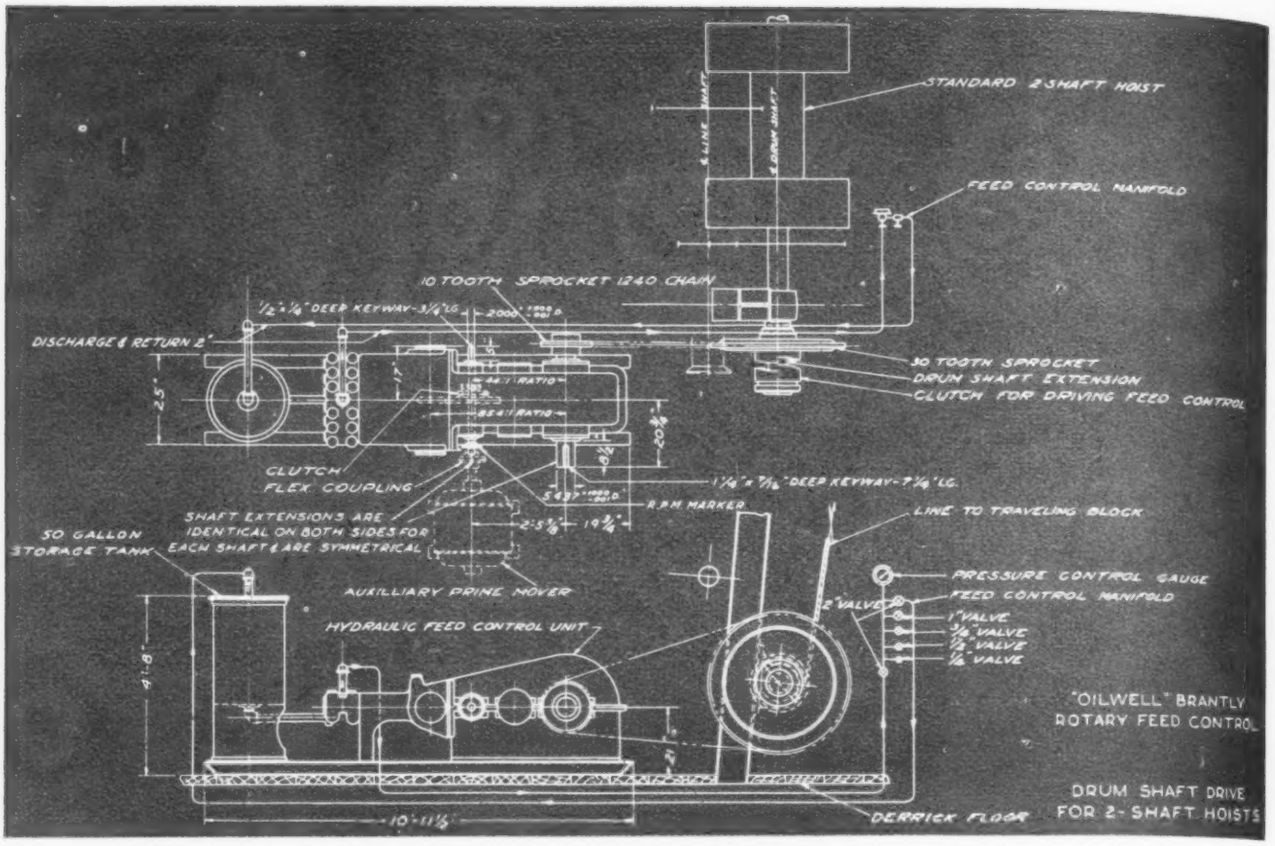
Of particular interest is the principle of operation of this important rotary drilling accessory. Power required to actuate the feed control is derived solely from the tension in the drilling line. The drumshaft torque resulting from the tension in the drilling line is utilized to drive a small pump through a reduction gear. The discharge rate of this small pump, which uses water as a fluid, governs the feeding rate of the bit. By means of a manifold on the discharge line of the pump, any desired rate of discharge can be obtained simply by adjusting the size of the discharge outlet to the required amount.

In construction the feed control is a compact self-contained unit that can be installed and moved with ease. It consists of an oilbath fully-enclosed double-reduction gear and a small six-cylinder double-acting power pump, 1¾-in. bore and 2½-in. stroke. The reduction gear and the pump are built into a single unit that is mounted on steel skids. A steel water tank, from which the pump takes its suction, is also mounted on the same skids. The discharge manifold, which includes the orifice valves for regulating the pump pressure and speed, is conveniently placed adjacent to the driller's position on the derrick floor. The low-speed shaft is driven by a chain from the sprocket and clutch on the drumshaft or the lineshaft of the hoist, depending on the type of hoist used. From the drumshaft of the hoist to the pumpshaft of the feed control the overall speed ratio is 250 to 1. The arrangement of the feed control is shown on the accompanying drawings on pages 28 and 29.

All working parts of the power end of the pump and the complete reduction gear assembly of the feed control are fully-enclosed and amply lubricated by oilbath and splash. The gears are of single-helical construction and are fully heat-treated for best wear characteristics. The bearings are all of the tapered roller type. The speed ratio is so great that the fluid pressures are low even with the heaviest drill pipe loads, thus making the wear and tear on the pump parts negligible.

The discharge manifold is a single unit of unique construction. Five orifice valves, in sizes from ¼ in. to 2 in., are incorporated in the manifold to govern the rate of fluid discharge, which, in turn, governs the feeding rate of the bit.

The operation of the feed control is very simple. When making a round trip or adding a joint of drill pipe, the drive clutch for the feed control is automatically disengaged. To resume drilling, the bit is lowered to the bottom of the hole and is then picked-up about three ft., at which time one drive clutch is engaged and the hoist brake is entirely re-



Drawing shows the hook-up of the Rotary Feed Control on a drum-shaft drive for 2-shaft hoists

leased. The bit is then lowered to bottom by opening the largest orifice valve in the discharge manifold, thus permitting the pump to discharge freely. When the bit reaches bottom, all the valves are closed except the one that provides the desired rate of feed; rotation is then begun as in regular drilling practice.

Many advantages claimed for this new feed control have been demonstrated in actual field performance. Some of the most outstanding of these are:

More Hole Per Bit.. A uniform rate of feeding is provided in place of the irregular rate that results from hand-feeding. It is a well-known fact that in the metal-cutting industry, hand-feeding a cutting tool results in inefficient removal of the material and short cutting-life of the tool. The same principle holds true in rotary drilling operations, for a rotary drilling rig is nothing more than a huge drill press that uses slush as a cutting compound. The more uniform the rate of feed, the more efficient the cutting action of the bit will be and, consequently, the greater the amount of hole that will be drilled per bit.

More Hole Per Hour. Since the feed control assures a uniform rate of feed and maximum cutting-life of bits, a minimum number of round trips for replacing bits is required. The reduction in the number of round trips results in a like reduction in overall drilling time.

Straighter Hole. It is a well-known fact that an irregular rate of feed, such as results from hand-feeding, often causes the bit to deviate widely from the vertical. It follows, therefore, that a uniform feeding rate, such as is assured by the automatic feed control, is essential to the drilling of straight holes. Since the requirements regarding the straightness of holes are constantly becoming more severe, this feature of the feed control is of utmost importance.

Twist-off Hazard Reduced. Drilling is made safer and easier by relieving the driller from continually riding the brake lever. When the feed control is used, there is little danger of a twist-off or other serious trouble when a sudden change of drilling conditions occurs even though the driller does not happen to be near the controls at the time. For instance, if the bit should strike a fissure while it is being fed by the feed control, the drill pipe could not drop immediately because the line would not unspool any faster than the rate for which the manifold valves are adjusted. This "lag" gives the driller ample time to catch the pipe before any damage is done.

In case of an emergency requiring a reduction in the feeding rate, the speed is semi-automatically reduced. For example, if the bit is broken or strikes a shell or for any other reason ceases to cut at the rate of feed for which the feed control is set, the decreased tension in the drilling line tends to reduce the speed of the feed control because of the reduced drumshaft torque available for driving it. If the trouble in the hole is cleared up promptly, the drilling line is again subjected to the proper tension and the feed control resumes the predetermined rate of fed.

Uniform Weight on the Bit. It is almost physically impossible for a driller to keep the brake so accurately adjusted that the drilling line is fed from the drum at a rate approaching uniformity. The best he can do is to feed the line in

"bunches" with the result that the weight on the bit is varying continually. When drilling with the feed control, the brake lever is released entirely and the rate of feed is absolutely uniform. This absolute uniformity of feed is maintained whether the drilling rate is one ft. per hour or 50 ft. per hour. Feeding the line smoothly from the drum is advantageous when reaming or coring as well as when drilling.

Wide Range of Feed Rates. The valves in the discharge manifold provide a full range of orifice sizes so that any desired rate of feed between one ft. per hour and 50 ft. per hour can be used. So great is the speed ratio between the drumshaft of the hoist and the pumpshaft of the feed control that even at very low rates of feed the quantity of fluid discharged by the pump is sufficient to permit accurate control without the adjustment being unstable or unduly sensitive.

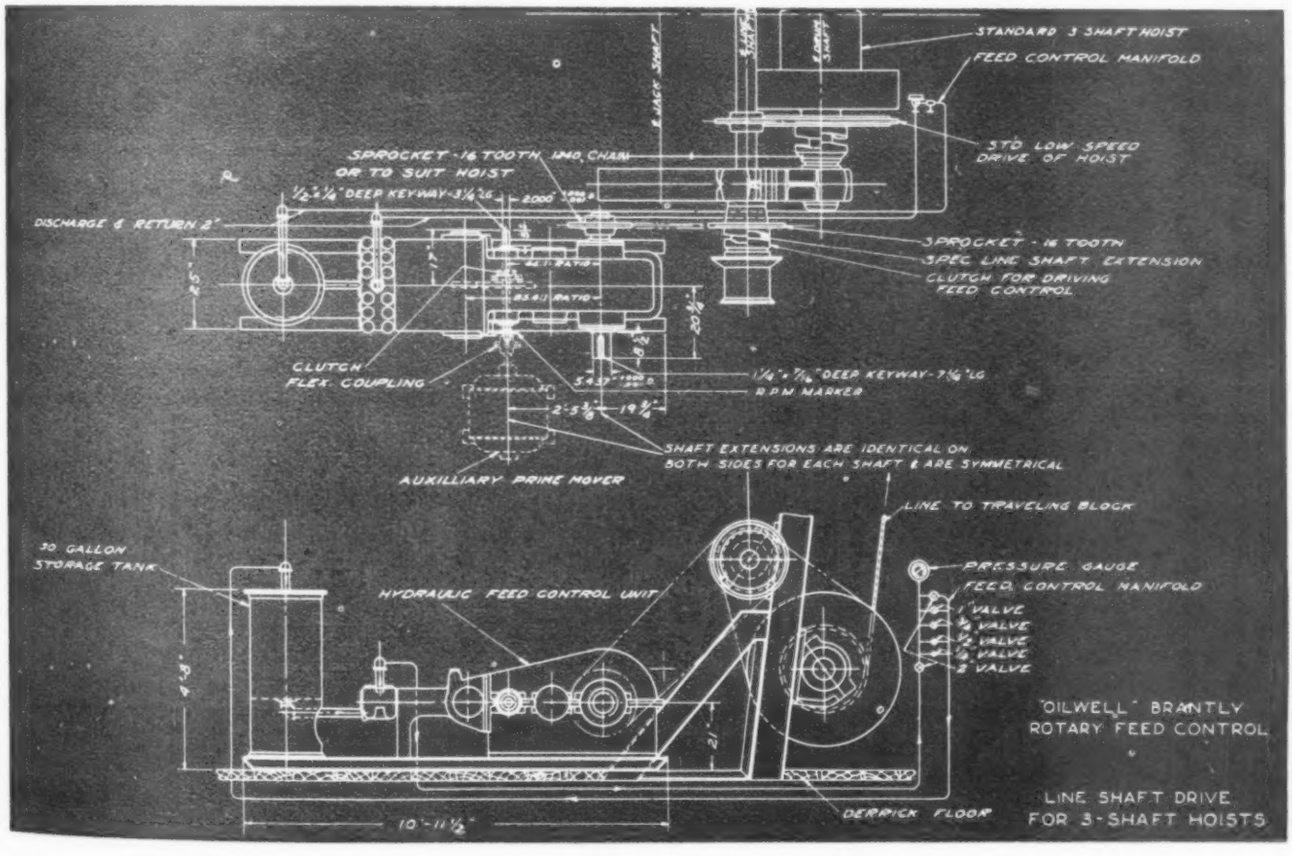
Holds Drill-pipe Load of 200,000 lb. Off Bottom. The heaviest drill-pipe load can be held off bottom by closing all the manifold valves of the feed control, thus stalling the pump and preventing the drum from turning. This can be done without creating excessive pressure on the pump, which is proportioned so as to keep maximum pressures relatively low. For instance, with eight lines in the derrick and a drum spooling diameter of 32 in., the pump discharge pressure will not exceed 170 lb. per sq. in. when a 200,000-lb. drill pipe load is held off bottom.

Auxiliary Means for Moving the Drill Pipe in an Emergency. The pinion shaft of the feed control gear box is extended outside the case (see accompanying drawing) so that a small prime mover can be used to drive through the gears back to the drum and thus lift the pipe in case of an emergency, such as the failure of the main prime mover. For example, a 25-hp. prime mover used in this manner will lift a drill-pipe load of 150,000 lb. with eight lines at the approximate rate of five ft. per minute. A clutch is provided so that the pumpshaft can be disconnected from the pinion shaft when the feed control is used for lifting the drill pipe.

Operates at Conservative Pressures and Speeds. If a piece of machinery is to be successful, it must operate under conservative and safe conditions, it must require minimum attention, and it must be simple to operate and keep in repair. The inventor, J. E. Brantly, and the designing engineers of the Oil Well Supply Company developed the Brantly Rotary Feed Control to meet these requirements as well as to provide the many advantages that facilitate straight-hole drilling and tend to make a rotary drilling rig more efficient. Wear and tear are negligible, for the fluid pressures are low, the speeds of the working parts conservative, the construction sturdy, and the lubrication efficient. Far from being a delicate piece of machinery, the feed control is a rugged, simple, and fool-proof piece of rotary-drilling equipment that is built for dependable service and long life. Being self-contained and of light weight the unit can be easily and inexpensively transported.

Before the end of 1934, 50,000 ft. of hole had been drilled with this feed control, and the performance throughout was reported as satisfactory. Experience indicates that this accessory plays a highly important part in reducing drilling costs and hazards. This new type of feed control has all the earmarks of being a real contribution to the art of rotary drilling.

Drawing shows the hook-up of the Rotary Feed Control on a lineshaft drive for 3-shaft hoists


STANDARD 3 SHAFT HOIST
FEED CONTROL MANIFOLD
STD LOW SPEED DRIVE OF HOIST
SPROCKET - 16 TOOTH
SPEC LINE SHAFT EXTENSION
CLUTCH FOR DRIVING FEED CONTROL
SPROCKET - 16 TOOTH 1240 CHAIN OR TO SUIT HOIST
DISCHARGE & RETURN 2"
CLUTCH FLEX. COUPLING
R.P.M. MARKER
SHAFT EXTENSIONS ARE IDENTICAL ON BOTH SIDES FOR EACH SHAFT & ARE SYMMETRICAL
AUXILLIARY PRIME MOVER
LINE TO TRAVELING BLOCK
30 GALLON STORAGE TANK
HYDRAULIC FEED CONTROL UNIT
PRESSURE GAUGE
FEED CONTROL MANIFOLD
1" VALVE
¾" VALVE
½" VALVE
⅜" VALVE
¼" VALVE
"OILWELL" BRANTLY ROTARY FEED CONTROL
LINE SHAFT DRIVE FOR 3-SHAFT HOISTS
DERRICK FLOOR

Application of Power to Dr Operati

By G. H. WECKE Kan
& Electri Cor
Wichit K

Above: Greenwich field, Kansas, during early development. Almost 100 per cent electrically drilled. Of the total of 43 wells in the field, 30 are now being pumped with electric power

Right: 75-hp. electric motor driving cable-tool outfit through O.C.S. unit, Valley Center field, Kansas

THE first application of electric power to drilling operations in Kansas was in the old El Dorado field. In the development of this field only cable tools were used.

At the present time there are two types of electric cable-tool drilling sets; namely, single-motor and twin-motor installations. The original single-motor outfit was of 75-hp. capacity, but in recent years the use of 125-hp. units is not uncommon. The no-load motor speed is either 720 or 900 r.p.m. The variation in speed required for proper drilling motion is obtained by means of an 11- or 12-point main controller in conjunction with a 14-point auxiliary controller. The combination of these two controllers provides a possible 168 different speeds, one of which should be fairly close to the drilling motion desired. In operating this type of equipment the driller should be particularly careful to place the auxiliary controller in the wide-open or highest-speed position before attempting any hoisting. The auxiliary grids are designed for imparting the drilling motion only and will not withstand the higher current taken to the motor during hoisting or running casing.

Twin-motor drilling sets consist of two double-rated, two-speed units, each motor belted to a common jackshaft with a center pulley belted to the bandwheel. The motors are rated either 20/50-hp. or 25/65-hp. with full speed on the low rating of 600 r.p.m. and on the high side of 1200 r.p.m.

Operations such as drilling, spooling lines, reaming bits, etc., are performed on the low rating, and "coming out" with tools, bailing, running casing, etc., are done on the high rating, high-speed position. Fine speed adjustment for drilling motion is obtained by lagging either motor one, two, or three controller points behind the other.

It is difficult to say which type of equipment is most satisfactory. The single-motor equipment has the advantage of being simplified, easier to transport, quicker to install, easier to keep in adjustment, and slightly cheaper to operate. The twin-motor equipment is more flexible in operation, has greater speed range and will develop more power. The twin motors, on the high rating, will develop from four to five times normal full-load torque without any appreciable slacking in speed. Most twin-motor outfits have pulley ratios to provide a maximum bandwheel speed of from 90 to 100 r.p.m. With this high bandwheel speed the time required to bail out is reduced very materially, thus making it possible to continue to carry the water in many cases that would otherwise call for an underreaming job and lowering of the pipe to shut off the water.

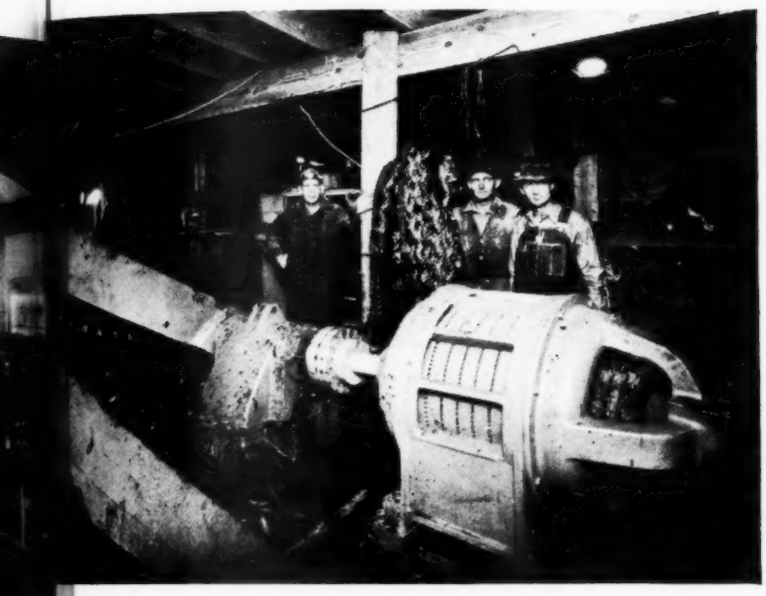
TABLE I—ELECTRIC CABLE-TOOL DRILLING

Well	Depth in Ft.	Kw-hr. Used	Total Cost in Dollars	No. of Days	Kw-hr. per Ft.	Cost per Ft. in Cents	Cost per Day in Dollars	Cost per Kw-hr. in cts.	Motors Conn. Hp.
A	2614	20,920	335	28	8	12.8	11.95	1.60	1-75
B	2618	23,330	373	33	8.9	14.2	11.30	1.60	1-75
C	2953	19,560	340	19	6.6	11.5	17.90	1.74	2-20/50
D	3458	48,944	783	71	14.1	22.7	11.00	1.60	1-75
E	2612	24,000	437	29	9.2	16.7	15.00	1.82	2-20/50
F	3458	43,680	699	50	12.6	20.2	14.00	1.60	2-20/50
G	3308	47,380	945	69	14.3	28.6	13.70	1.99	2-20/50
H	3248	50,010	948	64	15.4	29.2	14.80	1.89	2-20/50
Avg.	3035	34,700	607	45	11.4	20.0	13.50	1.75	

# of Electric Drilling Operations

Kansas Gas Company
Kansas

Above: 75-hp. cable-tool motor belted to countershaft, Valley Center field, Kansas



Left: 200-hp. electric motor on rotary drawworks, Greenwich Pool, Kansas

Table 1 shows data taken on eight wells drilled with cable-tools and electric power.

From a speed angle, the well "C" in Table 1 probably is a record for cable-tool drilling. Twin 20/50-hp. equipment was used, completing the well to 2953 ft. in 19 days, an average of 155 ft. a day. It will be noted that, based on daily cost of power, this well averaged $17.90, compared with the eight-well average of $13.50, but can be accounted for, since a well drilled with such speed would have to have the motors operating at a very high load factor. However, on the basis of power cost per ft., it will be noted that this well averaged 6.6 cents, as compared with 11.4 cents for the eight-well average, or slightly more than half. The contractor who drilled this well also drilled several others at speeds approaching this record time.

Electric rotary drilling was first introduced in Kansas in the spring of 1929, immediately following the discovery of the Greenwich pool. As a result, this entire field, with the exception of three wells, was drilled with either electric rotary or electric cable-tool equipment.

The motors used to operate electric rotary equipment are of fairly standard type as far as mud-pump drive is concerned. A 900-r.p.m. or 720-r.p.m. variable speed motor with ratings from 150 hp. to 250 hp. is in universal use. To operate the drawworks, a variation of types are in use. Until recently the usual practice was to equip the drawworks with a motor that was identical with the mud-pump motor, and consequently interchangeable.

Another early type, and one that is still in use, is the Hild differential drive. It consists of two double-rated 25/65-hp. motors, both driving the drawworks through a large differential gear. The proper pressure on the drill bit is supposed to be maintained automatically through this hook-up.

A later type of drawworks drive consists of dual drive through a common reduction gear with two 125-hp. motors supplying the motive power. During the drilling operation the switch of one motor is left open and the load carried entirely by the other unit. This method maintains high efficiency under varying load conditions. When "coming out" or "going in" with the drill pipe both motors are put in operation, thus making double capacity available for this heavier duty.

Last, for drawworks drive we have a double-rated, single-motor unit. The motor, which is usually rated at 85/250 hp. at 720 r.p.m., is operated on the low rating during the drilling operation and on the high rating when hoisting or lowering the drill pipe. The double-rating feature of this unit enables it to maintain maximum efficiency at varying loads with consequent reduction in power cost.

An idea of the economy of electric power for rotary drilling can be had from Table 2, which shows data obtained from eight wells drilled with electric rotary equipment during 1934.

A very important item favoring electric rotary operation

TABLE 2—ELECTRIC ROTARY DRILLING

Well	No. Days	Depth in Ft.	Kw-hr. Used	Total Power Cost in Dollars	Cost per Ft. in Cents	Kw-hr. per Ft.	Cost per Day in Dollars
A	26	3480	72,920	$1045.00	30	21	$40.20
B	27	3491	83,760	1178.00	34	24	43.60
C	31	3490	73,920	1165.50	33	21	37.60
D	32	3490	92,950	1345.00	38	26	42.10
E	25	3495	89,800	1238.00	35	25	49.50
F	23	3495	74,700	1014.35	29	21	44.10
G	28	3500	111,440	1311.24	37	32	46.80
H	29	3515	88,500	1255.25	36	25	43.30
Avg.	30	3500	86,000	$1200.00	34	24.6	$43.25

is the relatively small amount of water required. Since no water is required except for mud circulation, an electric rotary can operate on 200 to 225 bbl. of water per day.

In Kansas, the oil field is very remote that does not have electric power service available for all operations immediately upon discovery or very soon thereafter. With this fact in mind, a contractor need not feel that if he invests in electric rotary equipment he might be able to use the equipment only on very few occasions.

The power equipment for a complete electric rotary composed of the largest equipment would cost approximately $25,000. This would include a 250-hp. drawworks motor with controls and reduction gear, two 250-hp. mud-pump motors, controls, and two 7¼x14 mud pumps complete with V-belts and sheaves. This price would not include the material and equipment common to all types of *prime* movers.

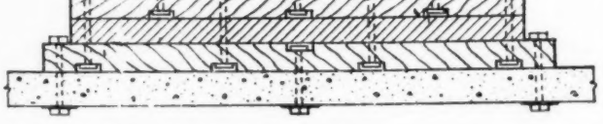
Perhaps the most acid test imposed on the prime mover of a rotary drilling outfit is its ability to develop the power needed in the hoisting of the drill pipe out of the hole. In most cases too much emphasis is placed on "coming out" speed, wherein the driller will shift to the next higher gear at improper times, thus increasing power requirements and consumption far in excess of the value in time saved; besides causing unnecessary depreciation of the prime mover as well as the equipment it operates.

In conclusion it should be stated that in view of the many factors affecting the application of electric power to oil field drilling operations, many definite claims can be made favoring its use, but the local conditions covering each situation should be carefully studied and the operator's decision based thereon.

How To Isolate Vibrating Machinery

By W. F. SCHAPHORST

THESE three sketches show clearly how to take care of machinery that is likely to vibrate and cause noise nuisance. One of the most effective modern methods, as indicated in the sketches, is to isolate shaky machines from the building or from the ground by means of a strong resilient material. Natural cork is generally regarded as best. Cork has a natural period of vibration that is invariably different from that of any machine, which fact is of great importance. Cork is almost perfectly elastic during a long period of years, which fact, too, is important. That is, cork does not gradually yield under pressure like most other materials. Cork does not rot, warp, swell, or shrink. From almost every viewpoint natural cork is an ideal material for machine isolation. Sometimes the work is placed directly under the machine on top of the foundation (see Fig. 1), and at other times the foundation itself rests on the cork (see Fig. 2), depending upon conditions. Thus. Fig. 1 shows how to isolate an electrically-driven unit, the unit being completely tied to a concrete slab in such a way that vibrations cannot be transmitted to the building, and yet the machine cannot jump off its base.



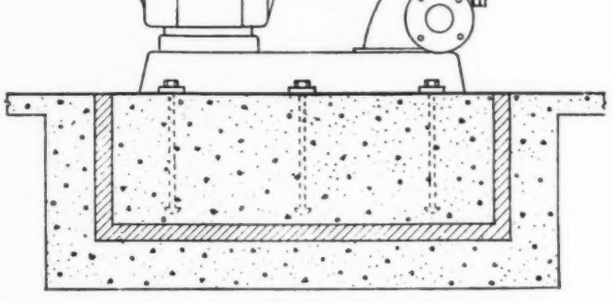
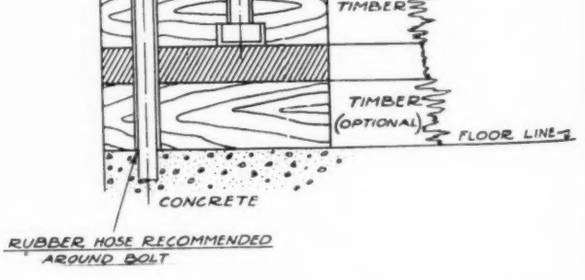


Fig. 2 shows how to isolate a machine without secondary tying bolts such as are shown in Fig. 1. In other words, the concrete base is here placed in a pocket lined with cork. This is usually a very satisfactory method of isolation.

Fig. 3 shows in greater detail how the bolts may be isolated and applied. The "rubber hose kink," for further isolating long through bolts, is a good one to remember. An objection to rubber is that it soon loses its elasticity, but for this purpose of merely surrounding a bolt that fault is of but little importance.

Through-tying bolts are important. One should guard against an erroneous design, such as the elimination of bolts tying a top slab of concrete to the lower slab. In other words, there is nothing to prevent the machine from bouncing around and dragging the top slab and the machine itself around on the floor. The designer may argue, "This machine doesn't vibrate that much." To which a logical reply is: "If the machine doesn't vibrate that much it very likely doesn't need isolating. Why not be safe and use through bolts? They don't cost much more and are much to be preferred."



The Manufacture, Packaging, and Shipping of Oxidized Asphalts

Article I

GENERAL INTRODUCTORY

By

CHAS. J. HOLLAND

THERE are two divisions of petroleum refining in which comparatively little engineering and scientific knowledge have been utilized. They are the manufacture of metallurgical shell still coke and of oxidized asphalts. In the methods and equipment for making gasoline and lubricating oil enormous progress has been made and most widely taken advantage of, but not so with coke and asphalt.

So far as the United States goes, it is easy to see why little is done about coke. As a rule, it is produced as a by-product in the making of gasoline and the market is either limited or so far away from the refining centers that transportation costs are almost prohibitive. It often accumulates in large refineries, with no apparent opportunity to sell it at a profit. It piles up into mountains until some wide-awake outsider comes and buys it up for a song. He then charters a ship and sells it in Europe at a handsome profit. Why he is able to do this is because there are profitable markets in European countries and foreigners know little about low cost manufacture of high quality metallurgical and electrical petroleum coke.

But with oxidized asphalts the picture is different. There are good markets for it all over the world. That is to say, the market exists or can be made by sufficient effort. From a fairly wide experience and observation, it is this writer's opinion that a good deal of profitable business in Europe and America awaits the firm willing to do some missionary work in the best methods for manufacture and sale of oxidized asphalts. There are hundreds of industrial uses, and the possible extent of sale for highway and pavement construction has only been scratched.

Try to convince the average refiner in Europe or America on this and one gets nowhere. Just the mention of the subject, in fact either one, coke or asphalt, is enough to cause apparent pains to his anatomy. If he talks at all it will be to say they are too costly to make; too dirty; specifications too variable and difficult to meet; customer complaints are overwhelming; they can be made only by old batch methods, and so on. A few venture in, make failures and rush out to tell others. So that the legend persists.

If for no other reasons than flexibility of operations and more efficient use of by-products, refiners should give exhaustive thought to the manufacture of these two products. As an illustration, some four years ago the writer recalls having attended a lecture by a man who had just completed a world-wide tour and survey of locations and markets for industrial and domestic heating oils. His chief conclusion was that over the next ten years there would be no increases in demand and price. He showed that although great increases had been made in consumption of gasoline and lubricating oils over a five-year period, there had been only a very small increase in consumption of liquid fuels. What increase there had been, he attributed to increased use of furnace oils and distillates for stationary and automotive Diesel engines and domestic heating purposes.

As to flexibility, most refiners have only one choice—to flood the market with gasoline or fuel oil. Today they are doing both. If they knew more about how to make efficiently and sell shell still coke and oxidized asphalts they probably would be using more black ink and less red in their auditing departments. Some refiners in recent years have gone part of the way by getting into the road oil and asphalt business but have done so by making steam-refined products only. Oxi-

The author of this series of articles, of which this is the first, is a consulting chemical engineer, resident in Dallas, who has had more than twenty years' experience in oil refining, more particularly with respect to naphthene and asphalt-base crude oils.

Mr. Holland has recently completed a five-year sojourn in Europe, one year of which he served as consultant for foreign clients, chiefly in Roumania, of the Arthur G. McKee Company of Cleveland. Following this assignment he worked in Germany and France for American and European firms.

During the three years of 1931 to 1934, he was the chief foreign consultant in Moscow for Glavneft, the headquarters of the petroleum oil department of the U.S.S.R. Commissariat of Heavy Industry.

Previous to his European engagements Mr. Holland did consulting work for major companies and independents in America and in Mexico. Since his return to the United States in the spring of 1934, he has been engaged in work relating for the most part to the manufacture of asphalt and petroleum coke, in Mexico and in Texas.

In the editor's opinion, readers of The Petroleum Engineer will welcome at this time with special interest this series of articles on the continuous manufacture, the packaging and shipping of oxidized asphalts; for, in a correlative respect, they bear an important relation to the methods of solvent refining of lubricating oils. Particularly as with the solvent treatment of naphthene and asphalt-base crudes, there are derived as by-products residual tars adaptable as charging stocks for the continuous manufacture of high grade oxidized asphalts.

We concur in the belief expressed by Mr. Holland that given a better knowledge and appreciation of the general principles and detailed methods of continuous oxidizing plant design and operation, many refiners will renew their interest in the possibilities of oxidized asphalt production. Especially should this be true of those now installing solvent processes for lubricating oil manufacture.

dized asphalt manufacture has, if anything, decreased in the past few years. There are two reasons for this. One is that former big consumers have found it to their advantage to buy heavy fuels and residues, build their own oxidizing plants, and make what they previously bought from the oil companies. Another is the increase of small refiners selling steam-refined asphalts by the expedient of persuading buyers to set up specifications that tend to keep out oxidized asphalt competition. This is an old trick, used for years in the sale of lubricating oils. Yet oxidized asphalt manufacturers seem not to have interested themselves in holding on and getting more business. Some have given up while others follow the herd in the more expensive way of going in 100 per cent for manufacture of steam-refined asphalts.

People will say it's not possible to do much oxidized asphalt business because of impossibility of meeting certain specifications of the buyers. Ductility crowds it out in one case, specific gravity in another, and so on. There is, of course, some truth to this. There are manipulative means of manufacture not so well understood by the usual run of experts that assist in overcoming these drawbacks of oxidized asphalts. But equally important, they are sales problems as well. For it is ridiculous for a road building buyer to specify infinitely small limits on specific gravity and very high ductility tests when he knows he will use only six to twelve per cent asphalt, and everything else—such as the rock, the sand, the lime, the subsoil—will come from many local sources and will be of different physical and chemical characteristics. If he is a road builder who knows his business, he knows, too, that one ductility test at a specified temperature doesn't mean much. He knows what counts is the relationship between a series of ductility tests and temperatures—the so-called susceptibility factor, wherein oxidized asphalts excel those of steam-refined origin.

Again, it may be said it's cheaper to make steam-refined asphalts. It would have to be a very special situation for that to be true. Once an efficient continuously operated oxidizing plant is built and in satisfactory operation the total costs for air, steam, and fuel will run in the neighborhood of five cents per ton of finished asphalt. When steam refining, the costs of steam alone will be greater than this and fuel oil costs will be at least that much. As a rule, it will cost two and three times more to make steam-refined asphalts.

Steam costs in a refinery seldom run lower than 30 cents per 1000 lb.; often 40 to 45 cents. In the following tabulation 35 cents is assumed to be a good average.

Assume a pipestill atmospheric distillation unit charging a stock composed of a mixture of 15 per cent gasoline and 85 per cent 250-300 penetration asphalt derived from Panuco crude oil. Assume further that the yields of asphalts of penetration from 110 to 65 will be 80 per cent; 65 to 45, 78 per cent, and 35 to 25, 75 per cent. Under these conditions the following figures will be typical:

COST OF STEAM FOR MAKING DIFFERENT GRADES OF STEAM REFINED ASPHALTS

Penetration of Asphalt	Lbs. of Steam per: Bbl. of Chg. Stk.	Ton of Asphalt	Cost of Steam Per Ton of Asph.
110	24	180	6.3c
95	27	204	7.1c
65	36	276	9.7c
55	40	300	10.5c
35	46	360	12.6c
25	54	432	15.1c

That isn't all the story by any means. For example, when making the low penetration asphalts, throughput of the distillation unit is greatly reduced, down to 75 per cent or less, when going for 25-35 penetration products.

The formation of asphalt by means of oxidation with air is a process first worked out by Mabery and Byerly some 35 years ago (Am. Chem. Journal). On four or five days' treatment with air of the heavy residue of Ohio crude oil (sp. gr. of residue about 0.930), first at 475 deg. fahr., and next at about 640 deg. fahr., they obtained four different asphalt-like products having the following properties:

	%C	%H	%S	%N	%O	Sp. Gr.	Liq'd at	Br.No.
Asphalt Flux	86.22	10.91	0.30	0.18	2.39	0.956	77°F.	14.18
Paving Asph.	86.48	10.33	0.40	0.61	2.18	1.00	275°F.	14.93
Roofing Asph.	86.90	10.20	0.39	0.63	1.88	——	329°F.	14.40
Byerlite	87.44	9.31	0.41	0.64	2.20	1.04	500°F.	18.93

The hardest of these, Byerlite, is entirely soluble in carbon bisulfide, soluble to the extent of 62.45 per cent in ligroin and its character quite closely resembles the natural bitumen Gilsonite.

It is striking that the oxygen content of these four products, which otherwise differ so much in their behavior, is very much the same, i.e., that in the progressive oxidation, there is no enrichment of the asphalt in oxygen. The process of oxidation, therefore, takes place in a manner essentially different from that of the treatment of distillates with air, where the chief effect is always the formation of acids. It is further noteworthy that there is a rise in the Bromine number in the last phase of oxidation, which fact indicates the reformation of double bonds.

The quite considerable increase in consistence and hardness in the formation of artificial asphalts from crude oil residues by air oxidation makes it evident that polymerization also takes place. Unfortunately, Mabery and Byerley give no data on the molecular weights. During the oxidation, besides the formation of water the evolution of sulphurous and sulfuric acids was observed. A part of the sulphur was held back in the asphalt and its ratio to the sum of the carbon and hydrogen remained but slightly changed, indicating that the sulphur was not oxidized away from the intact organic molecules but was burned along with the entire molecule. Finally, attention is invited to the very marked increase in the percentage of nitrogen during the course of the oxidation, which appears to show a fixation of atmospheric nitrogen.

U.S.A. ASPHALT STATISTICS 1932-33 (EXCLUSIVE OF ROAD OILS)
From U. S. Bureau of Mines Reports

	Consumption Tons	Value	Production Tons	End of Year Stocks, Tons
1932 . . .	2,408,818	$18,605,117	2,474,919	298,684
1933 . . .	2,424,800	23,542,544	2,456,051	276,363
	Avg. per Day	Avg. per Ton	Avg. per Day	Exports	Imports
1932	6,600	$7.72	6,780	206,006	20,474
1933	6,643	9.71	6,729	204,032	21,706

As will be noted, consumption and sales were almost the same for both years, but value increased 26.5 per cent in 1933. Exports and imports were also much the same; less than eight per cent and one per cent, respectively, of domestic consumption. Approximately 50 per cent of production was made from foreign crudes, i.e., Venezualian, Columbian, and Mexican.

The shift in uses of asphalt, made manifest in 1930, continued in 1933. Cut-backs gained in relative importance, 8.1 per cent of all asphalt sold in 1930 to 21 per cent in 1933, while paving asphalt decreased from 42.4 to 32.9 per cent and roofing asphalts from 26.2 to 20.4 per cent.

(In succeeding articles will be described commercial plants in America and Europe, the basic principles of which are still applicable today. Following these descriptions will be given a list of 15 basic principles, their discussion and application to modern continuous plant design and operation).

Making Field Tests of Rubber Pipe Line Coating

By FRANK H. LOVE

FOLLOWING five years of research in an effort to develop a rubber pipe-line coating capable of protecting against corrosion, The B. F. Goodrich Company, Akron, Ohio, is now making in Texas its first field tests. One test was instituted on the Lone Star Gas System's 10-in. line ten miles southwest of Waxahachie where the soil is known to be extremely corrosive. A 100-ft. section was removed from the company's line and replaced with an equal length of new pipe coated with rubber. Subsequent to the Lone Star installation another was made on a 3-in. gasoline line of the Magnolia Pipe Line Company between Luling and San Antonio, Texas. In this instance the existing line was looped for a distance of 300 ft. where the soil also was highly corrosive.

Periodical inspections will be made of these two tests, as well as a third to be made soon on a crude oil line, and it is thought that, at the end of two years, or perhaps sooner, it can be definitely determined whether the use of rubber on pipe lines for protection against corrosion is practicable.

On the Lone Star installation the 100 ft. of pipe was composed of five 20-ft. sections. The sections were coated with the rubber product at the factory, the pipe being furnished by the Lone Star Gas System and shipped to Akron where it was first wire-brushed to remove dirt and loose scale, after which unvulcanized rubber strips were cemented to its surface. The strips were cut two inches wider than required to reach around the pipe, far enough for overlapping. In this unvulcanized stage the rubber is of a soft texture, but when put through a vulcanizing operation, a direct steam-heated process, it becomes of a flexible hard consistency, resembling in its physical appearance a good grade of sole leather. It has a fairly high tensile strength and is virtually immune to physical damage, Goodrich engineers state. The rubber coating was vulcanized onto the pipe's surface to a thickness of 1/8 in. and to within eight in. of each end of the pipe, the latter permitting welding without danger of burning the rubber.

Upon reaching the field the 20-ft. joints of pipe were electrically welded and vulcanized soft rubber sleeves 30 in. in length placed over the welded joints, extending back seven in. over the flexible hard rubber coating. The sleeves were then cemented in place with a special rubber cement and wired into compression, forming a continuous insulated line. With the sleeves thus compressed against the pipe and hard rubber coating, a freeze develops in time between the hard and soft rubber, rendering them virtually integral. In compressing the sleeves it is recommended that cadmium-plated wire be used, since it must be rust and corrosion resistant in order to hold the sleeve tightly in place for a period of approximately six months, or until the freezing process is well under way.

After lowering into the ditch the test section was coupled into the line with Dresser couplings, the center rings of which had been coated with the same rubber compound as the pipe. The accompanying illustration shows the pipe immediately before it was lowered into the ditch. The rubber sleeves are easily discernible.

A 100-ft. section of 10-in. pipe coated with rubber ready to be lowered into the ditch and coupled into the Lone Star Gas System's line southwest of Waxahachie, Texas

Five years ago The B. F. Goodrich Company initiated a search for a rubber compound that could be used successfully as a pipe-line coating. Laboratory experiments developed one that was thought suitable from the standpoint of ease of installing, long life, etc., and it was given a mechanical test to determine its resistance to soil stresses. This test was made by burying pipe coated with the rubber compound in a box containing soil, and after applying pressure to the surface of the soil, moving the pipe backwards and forwards. When this test was pronounced successful, the United States Bureau of Standards was asked to coöperate and samples of rubber-coated pipe were buried in a marsh reputed to be the "hottest" spot in the State of Ohio. Recently the samples were examined after being buried two and a half years and the bureau reported the coating in excellent condition. With these preliminary tests as a background, the next step was to determine the value of the product in actual field application, which led to the tests aforementioned.

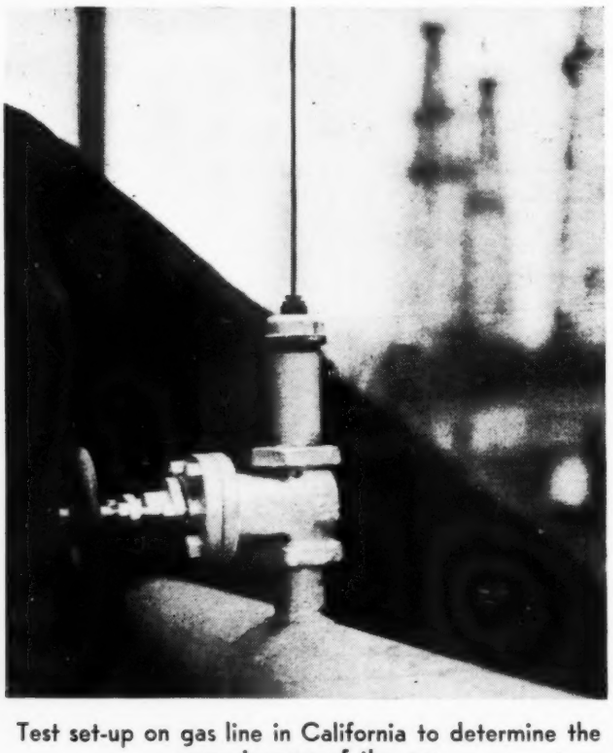
Dr. H. E. Fritz, manager of chemical tests and development for The B. F. Goodrich Company, and T. D. Nathan, development engineer for the mechanical department, both from headquarters at Akron, were in charge of the Lone Star and Magnolia installations. Assisting them were George A. Livermore, special factory representative, and D. R. Anderson, of Dallas, district sales manager, mechanical division.

Corrosion of Gas Pipe Lines in California

By
J. C. ALBRIGHT

NATURAL gas produced in California has been generally considered to be free from hydrogen sulphide and other corrosive agents. A few years ago, however, several instances were discovered to substantiate a theory that this gas did contain some corrosive substance because of certain conditions in gas transmission mains of several of the distribution companies operating both in Southern California and the northern part of the state. While the hydrogen sulphide concentration in California gas is extremely small compared to that in some of the gas produced in the Texas Panhandle and Southwest Texas, corrosion of pipe lines, orifice meter plates, and other pipe line fittings has been great enough to warrant an extensive study of the subject by those in the industry, particularly those transporting and distributing large volumes of fuel under high pressure to the large cities on the Pacific Coast.

Practically all the indications of corrosion of pipe line or fittings found in California gas lines have been where pressures have been high. No instance has been brought to light or discovered where corrosion or incipient deterioration of pipe line accessories has taken place where the line pressure is less than 75 lb. per sq. inch. That discovered at the present time has been limited to areas within the line only a few miles away from the compressor stations, but the results of corrosion have been felt many miles away because of the scale, which is carried along with the gas, interfering with proper measurement by affecting meter runs and contributing largely toward plugging pipe line drip connections.



Test set-up on gas line in California to determine the corrosiveness of the gas

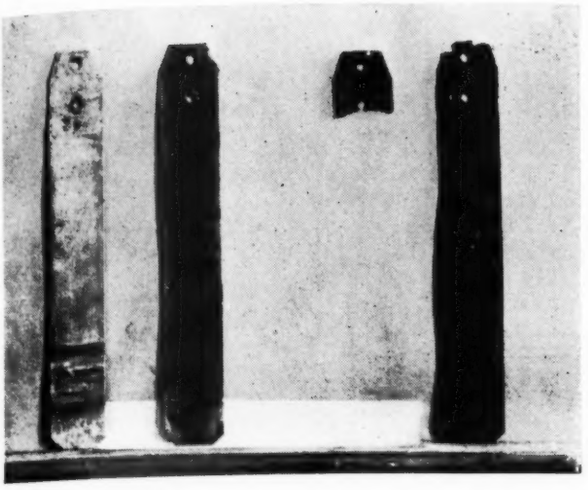
As internal corrosion of natural gas transmission pipe lines had not received the thorough study it had been given in Eastern and Mid-Continent fields, conditions in lines originating in Kettleman Hills when excessive drops in line pressure occurred were attributed to dirt and other foreign matter. This pressure drop had first been noticed by the Pacific Gas and Electric Company in its San Francisco line, and when it was opened for examination there was found to be a heavy deposit of finely divided black substance, together with large quantities of water. Samples of this substance and somewhat similar deposits from the Southern Fuel Company's line were analyzed. The result of the analysis is as follows:

Constituent	*P. G. & E. Line*	*Southern Fuel Line* ——*per cent*——	
Sample	solid	solid, 15.45	liquid, 56.55
Acidity as H_2SO_4	.59	.....	neutral
Loss on ignition	12.44	14.22	
Silica	.14	5.76	
Ferrous Oxide	4.36	1.88	
Ferric Oxide	69.44	76.44	
Sulphur Trioxide	15.29	2.67	
Lime	None	.48	
Magnesia	.14	.44	
Soda	None	.10	
Potash	None	.10	
Sulphides	Trace	None	
Sulphites	Trace	None	

The chemical reactions involved in the corrosion appeared to the chemists to be many, depending greatly upon local conditions existing in the pipe lines. In all cases, they felt in the beginning that the first step in the action depended upon the dissolving of oxygen or hydrogen sulphide in the condensed water on the pipe walls. If dissolved oxygen reacts with the pipe, red iron oxide is formed, while hydrogen sulphide under the same conditions was found to form a black iron sulphide. In most cases investigated previously to the conditions found in Kettleman Hills, the pipe line deposits had been observed to consist largely of red iron oxide.

As previous experience had proven that sulphur and oxygen in the presence of water and under pressure, were very corrosive, an investigation was begun to determine the nature and extent of any corrosion damage, and to determine also, the concentration of both sulphur compounds and oxygen. Tests were conducted throughout the field at Kettleman Hills to determine the amount and prevalence of hydrogen sulphide and oxygen in the gas being produced. A tabulation of the results of these tests is as follows:

Location	*Grains Hydrogen Sulphide/100 cu. ft.*	*Per cent Oxygen*
Oil Co., 'A' High-pressure Intake	0.048	trace
Check Test	0.057	0.00
Oil Co., 'A' High-pressure Discharge	0.008	0.0026
Check Test	0.025	trace
Oil Co., 'A' Recompressor Gas	0.027	0.007
Check Test	0.045	0.0161



Copper sample strips. Left is new sample; others, after from three to six months' service

Location	Grains Hydrogen Sulphide/100 cu. ft.	Per cent Oxygen
Oil Co., 'A' Tank Vapors	..... (Orsat)	2.400
Gasoline Co., 'B' Plant Intake	0.022	trace
Check Test	0.031	trace
Gasoline Co., 'B' Plant Vapor	0.065	0.0048
Check Test	0.079	0.0037
Gasoline Co., 'B' Tank Vapor	0.000	.....
Check Test	0.021	0.600
Gasoline Co., 'B' High-pres. Discharge	0.022	0.0037
Check Test	0.034	trace
Check Test	0.034	.....
Gasoline Co., 'B' High-pres. Discharge	0.008	trace
Check Test	0.013	0.0053
Gasoline Co., 'C' High-pres. Discharge	0.018	trace
Check Test	0.087	0.0045
Southern Fuel, Main Line Valve No. 1	0.004	trace
Check Test	0.004	trace
So. Cal. Gas Co., Lease at Avenal	0.038	0.000
Oil Co.,'D' High-pressure Intake	0.038	0.000
Oil Co., 'D' High-pressure Discharge	0.042	0.000
So. Fuel Co., Main Line at Buena Vista	0.000	0.000

For the determination of sulphur, which the chemists had reasons to believe was present only as hydrogen sulphide, they used a method developed by the San Diego Consolidated Gas and Electric Company. This method is calorimetric and depends upon the formation of a distinctive yellow precipitate of cadmium sulphide, the intensity of the color being a measurement of the hydrogen sulphide concentration. Sensitized papers, which are prepared by treating a filter paper with a solution of neutral cadmium acetate, are exposed in a suitable chamber so that the gas flows through the paper while being tested. Color standards are prepared from these treated papers, using known concentrations of hydrogen sulphide. By comparison of the test paper with the standards and measurement of the gas volume, the concentration of hydrogen sulphide per 100 cu. ft. is determined.

When this test was used on gas produced from Kettleman Hills, considerable difficulty was experienced, some of which was as follows:

1. Quite large volumes of gas must be used in testing as the concentration of hydrogen sulphide is small.
2. To insure the removal of hydrogen sulphide, the gas must pass very slowly.
3. Widely variant moisture conditions were found that gave somewhat erratic results. For instance, the color intensity was not always constant for the same concentration. This probably was, as the chemists determined, to be attributed to the formation of CdS at one time only on or near the paper surface, while in subsequent tests a precipitation would be formed throughout the thickness of the paper.

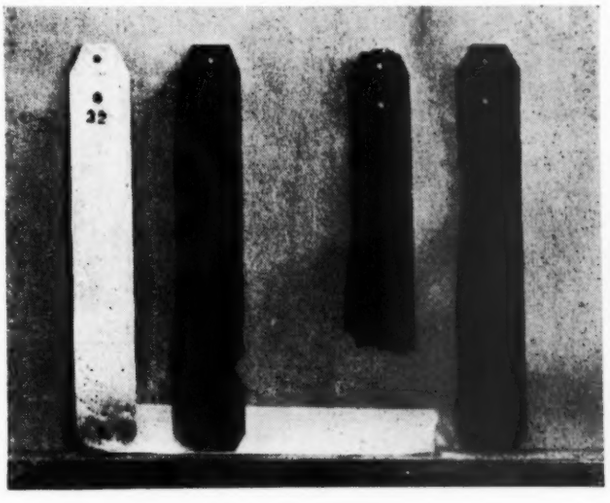
To escape this last difficulty, the method was modified and instead of using visual comparisons, the test paper was treated with $\frac{N}{100}$ I_2 in the presence of HCl with the following reactions:

$$CdS + 2HCl = H_2S + CdCl_2$$
$$H_2S + I_2 = 2HI + S$$

The excess I_2 was then titrated with $\frac{N}{100}$ $Na_2S_2O_3$ and the quantity of H_2S calculated.

When the lines in Kettleman Hills were examined, the corrosion was found to be fairly evenly distributed with the absence of numerous deep pits as found in other lines carrying higher concentrations of hydrogen sulphide. However, the deterioration of the lines was progressing in a gradual manner and a rough estimate of the condition was made. The chemists assumed that from a maximum concentration of 0.087 grains of hydrogen sulphide per 100 cu. ft. of gas and a transmission volume of 50,000,000 cu. ft. daily, there would be carried with the gas approximately six lb. of hydrogen sulphide. This, when combined with the iron under the existing pressure of 400 lb. and in the presence of water, which accelerated the reaction, the corrosive products formed in the first few miles of the line would amount to 14 lb. per day. Of this product, there would be approximately ten lb. of iron that would be removed from the side walls of the line. In the course of a year, if the conditions were not mitigated, there would be distributed throughout the transmission system an amount of scale equal to 2½ tons in weight.

This quantity of iron sulphide, if not formed from the actual removal of iron from the inside of the pipe in quantities sufficient to damage the walls, would form retarding substances to the flow of the gas, clogging drip connections, interfering with metering runs, and causing additional cutting and trouble within the distribution systems after the finely divided mass of sulphides had reached the cities and towns where the gas was finally utilized as a domestic and industrial fuel.



Examples of steel strips. Exposure in various conditions of pipe line service

Orifice plate removed from a meter installation in May, 1933, after three months' service. The line was under approximately 110 lb. pressure with approximately 2,000,000 cu. ft. per day being measured. Plate was originally 3.000 in. but had corroded to 3.250 to 3.400. Originally 1/8 in. thickness, it was razor-thin when removed. Black line shows original size.

To obtain information regarding internal corrosion, several companies operating pipe lines in California have devised set-ups for inserting metallic test strips into the gas stream for periodic inspection. These set-ups may be installed on the lines in operation without a shut-down and enables the research chemists to perform a continuous check at any number of points along a transmission line. These set-ups consist of nipples, 2-in. valves, caps, packing glands, and a brass rod to which is attached a metallic sampling strip with set screws.

The nipples and gate valves, with the other fittings, are installed on the line under operating conditions by the use of a tapping machine. The rod with the sample strip attached is inserted through the upper nipple, and the cap with its packing gland screwed in place. The gate valve is then opened and the rod with the sampling strip pushed downward so the strip is in the middle of the stream. Bridge crossings, existing vaults, and other convenient locations where the line is not covered are used for locations of these set-ups, eliminating the need for special vaults to be used in this connection.

If the corrosive action of any liquid traveling along the bottom of the line is desired, the sample strip is bent slightly about an inch from the lower end before inserting through the test connection, after which it is pushed downward against the lower side of the pipe. This places the lower inch of the sample strip in the stream of liquid, and the remainder of it in the gas flowing through the transmission line. Southern Counties Gas Company has installed approximately 30 of these test sets on their lines in the district where they operate. The sample strips are of either steel or copper and are inspected at least every three months. When they are removed for inspection, the visual condition of the strip is recorded, and if an unusually severe corrosion is evident from the surface of the strip, the loss in weight is also determined.

It has been definitely determined that if the gas to be transported through the transmission lines were dehumidified, the reactions taking place that cause corrosion would be mitigated, if not altogether eliminated. Through the activities of the Pacific Coast Gas Association, committees have been formed to investigate the problem. Several methods have been investigated, among which are: anhydrous calcium sulphate, trihydrate of aluminum and silica gel, and dehydration by the use of either propane or ammonia as a refrigerant.

An estimate of the investment required, together with an estimated yearly operating cost of a silica gel dehumidifying plant capable of handling 1,000,000 cu. ft. of gas per hr. under an operating pressure of 400 lb. per sq. in. is as follows:

1	Scrubber		$ 600.00
2	Absorbers at $408.00 each		816.00
4	8-in. Plug valves (cast steel) at $184.90 ea.		739.60
1	Gas Heater		400.00
4	2-in. flanged (400-lb. working press.) gate valves at $17.22 each		68.90
1	6-in. Motor valve		200.00
1	Flow Controller		325.00
1	Pressure Regulator		140.00
1	Gas Meter, 25,000 cu. ft/hr. capac. at 35 lb.		189.50
1	Gas Meter, 400 cu. ft./hr. capacity at 2 lb.		13.75
1	2-in. Regulator		24.75
3	2-in. Check valves (400-lb. working press.) at $13.59		40.77
1	2-in. Relief valve		43.01
3	12-in. Gate valves (400-lb. working press.) at $190.00		570.00
150	Sq. ft. cement pavement and footings		50.00
1	Electric time clock and alarm system		150.00
5	8-in. Tube Turns at $15.50		77.50
8	12-in. Flanged nipples, series 30, at $12.80 ea.		102.40
12	8-in. Flanged nipples, series 30, at $7.10 ea.		85.20
	Miscellaneous fittings, etc.		200.00
	Pipe		65.00
	Total materials		$4,901.38
Labor		$ 500.00	
Overhead (67 per cent of direct labor)		335.00	
			$ 835.00
One charge of silica gel (3024 lb.) at $1.00/lb.			3,024.00
	Total investment		$8,760.38

Operating Cost

Taxes	$ 148.70	
Interest (7% on $8,760.38)	613.50	
Depreciation of equipment exclusive of silica gel (10-yr. life six per cent sink. fund)	452.20	
		$1,214.40
Annual silica gel cost complete replacement every five years assumed	$ 605.00	
Fuel	180.00	
Labor	1,095.00	
Supervision	200.00	
Annual operating expense		$2,080.00
Total annual fixed charges and operating expense		$3,294.40

Several installations have been contemplated by the various gas companies in California handling gas that contains a trace or more of hydrogen sulphide together with moisture from the wells or gasoline plants that process the gas for its natural gasoline content before it is handled by the pipe line companies. One such plant has been installed on the discharge of a compressor station that uses ammonia as a refrigerant in removing the moisture, the value of which as a dehumidifier will be interesting to know, as the unit has not been in operation quite a year.

The writer wishes to acknowledge the valuable assistance given by A. B. Allyne, chief chemist of the Southern Counties Gas Company, Los Angeles, in the assembling of the data from which this article was written.

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Pressure Drilling— A Developed Drilling Technique

By WALLACE A. SAWDON,
Petroleum Engineer, Los Angeles

Marked progress has been made in recent years in the development of methods and equipment for the drilling and completion of high-pressure wells and is evidence of the growing importance of this phase of oilfield exploitation. This article, and also that beginning on page 53 of this issue, are the first of several to appear in this and successive issues on this all-important subject. The various practices followed in the fields of California, the Gulf Coast, and the Mid-Continent will each be discussed in turn in the articles to follow.

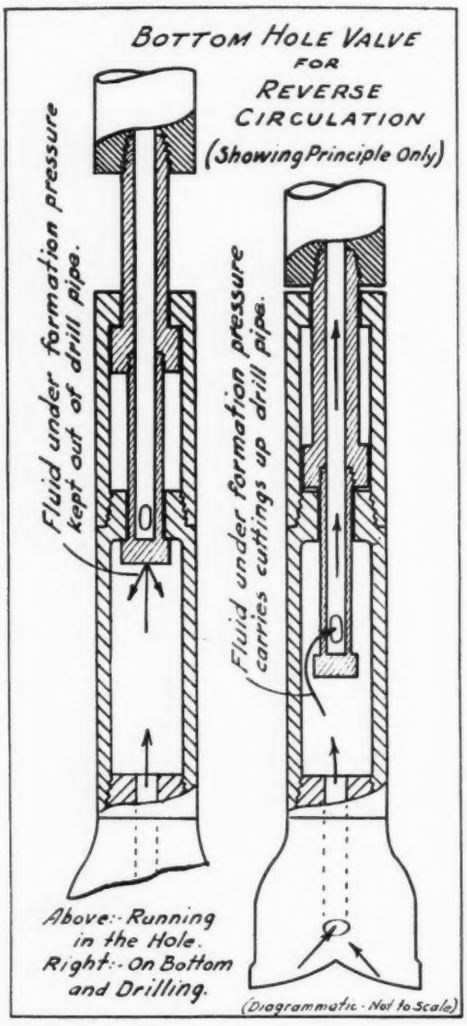

BOTTOM HOLE VALVE
FOR
REVERSE
CIRCULATION
(Showing Principle Only)
Fluid under formation pressure kept out of drill pipe.
Fluid under formation pressure carries cuttings up drill pipe.
Above:- Running in the Hole.
Right:- On Bottom and Drilling.
(Diagrammatic - Not to Scale)

Fig. 1. Back-pressure valve for reverse circulation. When tools strike bottom valve opens and allows the fluid carrying cuttings to enter the drill pipe.

DRILLING through and completion of wells in high-pressure formations can be expected to a greater extent than heretofore if further development of the oil resources of the world is to continue. Such drilling has been accomplished both by mud control and by pressure drilling; but present indications are that pressure-drilling methods will come into a more general use than they have in the past. There is no panacea for all ills; and there is no one method or type of equipment that is going to meet all subsurface conditions found in drilling for oil. The use of heavy mud fluid will probably meet some conditions satisfactorily; but the application of pressure on the fluid column in the well will be found necessary to meet others.

While the pressure may be controlled during drilling either by overcoming the formation pressure with a column of fluid the weight of which is greater than the formation pressure, or by the application of external pressure to the fluid, the term "pressure drilling" is here confined in its meaning to the latter.

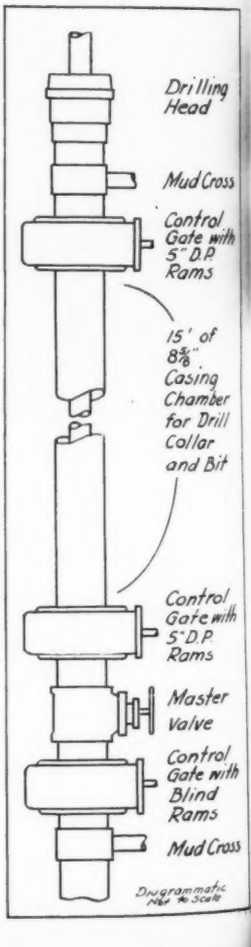
This external pressure, which will usually be greater than that of the formation, is generally supplied by pumps. With reverse circulation the formation pressure itself may supply the necessary pressure. In virtually all cases, pressure drilling involves a control of back pressure held on the circulating fluid. In pressure drilling the circulating fluid may be light or heavy, according to the conditions imposed; but there will be few cases where it will not have to be conditioned properly. The character of the formations or the available mud may necessitate either the addition or the removal, or both, of colloidal material or weight material. The cuttings must be disposed of. They sometimes present a problem that is, to say the least, inconvenient.

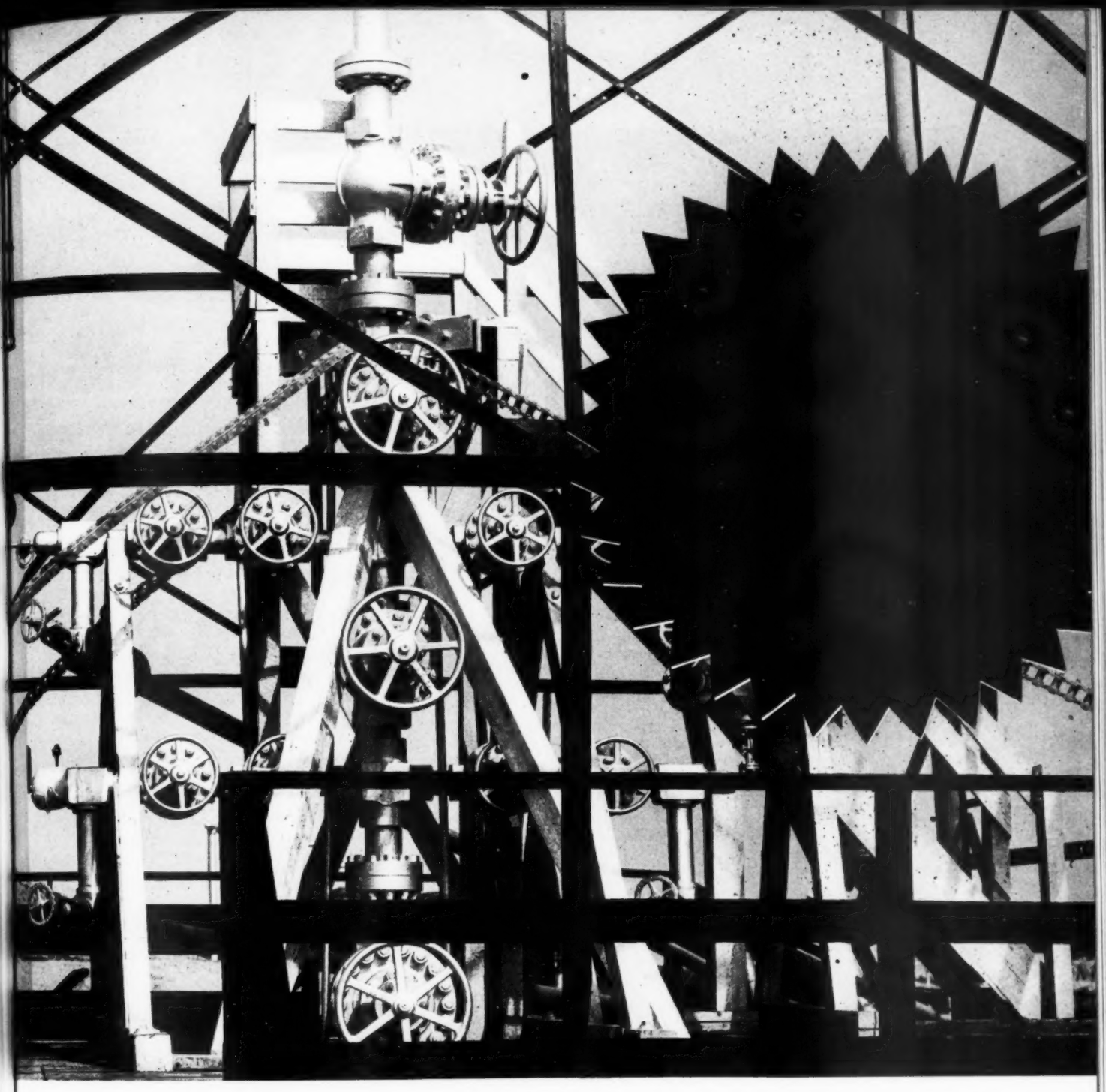
Application of Pressure Drilling

The selection of the pressure-drilling method for drilling or well completion does not depend entirely on the magnitude of the formation pressure encountered. Where the rock pressure is excessive, pressure drilling will usually be found advantageous; but there are conditions that will make its use very desirable. In general, the conditions that favor the use of pressure drilling are:

1. When the well is to be drilled through or completed in formations having a very high pressure.
2. When gas-cutting will endanger the operations or prevent satisfactory mud control or conditioning.

Fig. 2. General arrangement of control equipment in cellar of Attock Oil Co. deep test in the Khaur field, Punjab, India.


Drilling Head
Mud Cross
Control Gate with 5" D.P. Rams
15' of 8⅝" Casing Chamber for Drill Collar and Bit
Control Gate with 5" D.P. Rams
Master Valve
Control Gate with Blind Rams
Mud Cross
Diagrammatic Not to Scale



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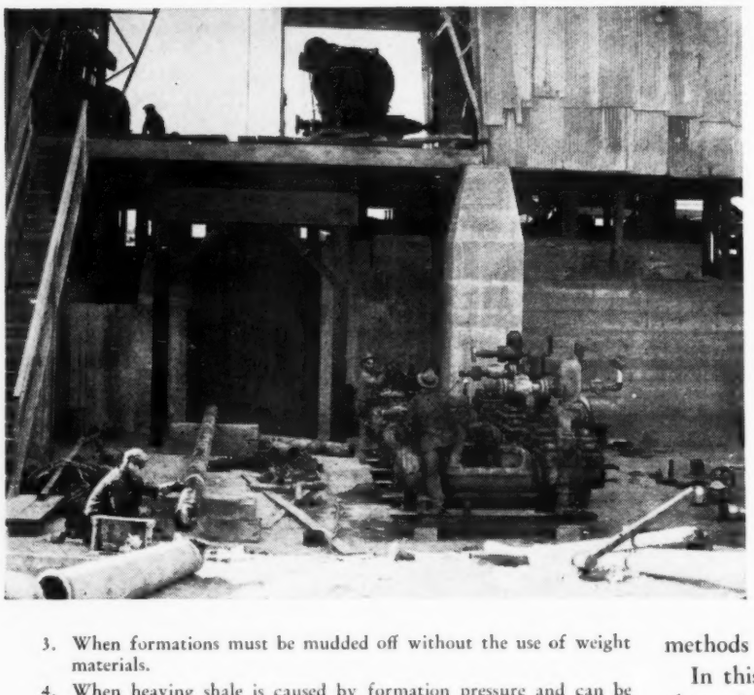


The cellar is a matter of considerable importance in pressure drilling. This one was in the process of construction on a well in the Lost Hills field, California.

3. When formations must be mudded off without the use of weight materials.
4. When heaving shale is caused by formation pressure and can be confined by maintaining on the formation a pressure in excess of that in the formation.
5. When water, gas, or oil must be kept in the formation during drilling operations.
6. When bringing in a well without mudding off the sand. Oil can be used when necessary, since the weight of the fluid column is not relied upon.
7. When a well is to be brought in under controlled flow, to prevent high initial velocities that might break down the walls and cause excessive heaving or caving.

There will, of course, be many specific problems that can best be met by putting on the fluid column a pressure greater than the formation pressure. The regulation of the back pressure with beans on the mud discharge provides a means of keeping the subsurface conditions under control and, besides facilitating drilling operations, reduces the hazard to a minimum.

Development of Pressure Drilling

Probably the first application of the principle of pressure drilling to oil wells was in drilling through a high-pressure gas stratum in the Kevin-Sunburst field near Shelby, Montana, in 1921. The work was under the direction of Fred Stone, who installed a packer similar to the common stuffing box and like those he had used in the late nineties to reverse circulation in wells used for prospecting for coal.

In this well, the company had passed through a gas stratum and was going on down when the gas blowing out of the hole caught fire and burned up the derrick. The stuffing box was then installed and, with the hole filled with fluid, the drilling was continued with a pressure of from 200 to 250 lb. carried at the surface.

The first pressure drilling in California was, according to Mr. Stone, on some steam wells he drilled about a hundred miles north of San Francisco in 1924. These wells were completed in scalding steam under a pressure of from 40 to 60 pounds. For additional safety, two stuffing boxes were used on each well with control valves above and below the packing. The wells were less than 500 ft. deep but were drilled until the temper could no longer be retained on the drilling cones. Cold water was used for circulation, but it would be converted into superheated steam before it reached the bit.

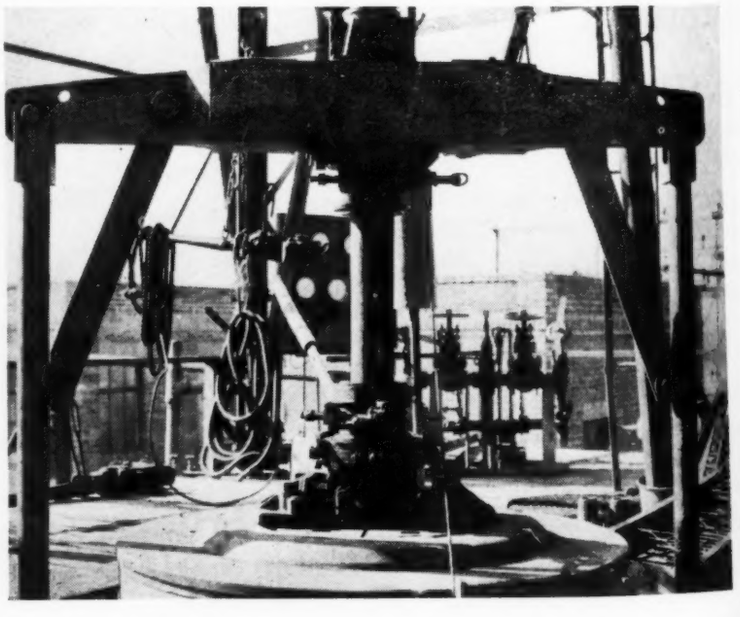
Probably the first pressure drilling in a California oil field was on a well in the Semi-Tropic district near McKittrick in 1926. In this well, a back-pressure of 300 lb. was kept on the fluid column.

The use of pressure drilling has been the means of solving some rather unusual problems in a number of foreign oil fields. Probably the earliest was in the Tampico area in Mexico and is of particular interest in that a development of pressure-drilling methods was made with diamond-drilling equipment.

In this territory, the oil came from a porous limestone at about 2000 ft. with pressures ranging from 1000 to 1500 pounds. The wells were being drilled with cable tools and some came in with initial productions as high as 150,000 bbl. of oil per day through 8-in. casing. Later, drilling was done through an oil saver but many of the wells had the tools blown out or stuck in the pipe or had their derricks burned down.

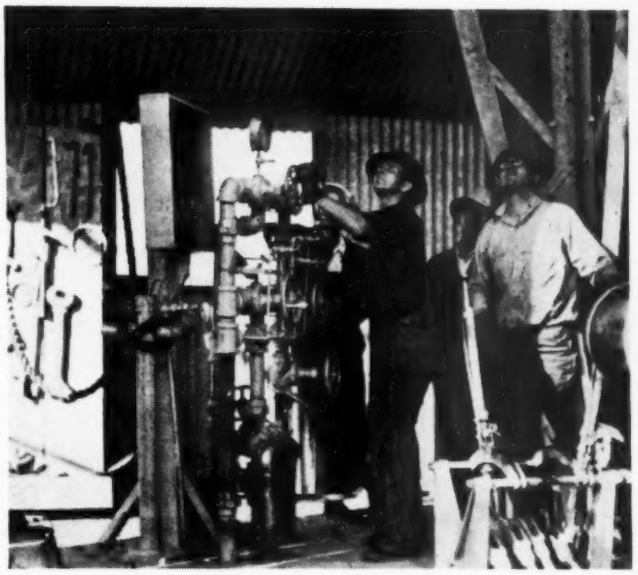
Diamond drilling was tried to some extent but there was considerable loss of diamonds, trouble with drill rods and a rapid cutting of joints. This equipment was probably just too light for the service to which it was subjected.

A contracting company in coöperation with the Mexican Eagle Oil Company then experimented in 1923 with pressure drilling, using rock bits with the diamond-drilling equipment. This equipment included flush-joint drill pipe, stuffing boxes and a snubbing-in device. Wells so drilled could be drilled to the depths desired without blowing out and with the fire hazard eliminated. The important result, however, was the ability to keep drilling after entering into the pressure zone.



This snubbing device is raised and lowered by hydraulic rams. The same type yoke can be operated with wire lines if necessary.

All the drilling controls are conveniently placed in this hydraulic rig.



Utilizing Formation Pressure in Reversed Circulation

An interesting case was the Mexican Eagle's well, Naranjos No. 36, drilled in 1925. This well was to make a deep test through the Tamisopa limestone to see if it could be penetrated and to locate an impervious stratum below which further production might be obtained.

The Tamisopa lime in this area is at about 2000 ft. and carries salt water of a temperature too hot for handling and has a pressure of approximately 550 pounds. The well was started with cable tools through an oil saver. The cellar was 30 ft. deep and the well was equipped with control gates. After the 10-in. casing had been cemented on top of the lime, drilling was too slow and a fishing job occurred.

Rotary tools were moved in and drilling resumed with flush-joint drill pipe. Unfortunately, the salt water could not be dumped into the creek or otherwise disposed of in any quantity, since it would interfere with pumping the oil from that district. Mud could not be used for drilling, since it would seal up the hole; so fresh water had to be pumped down and a pressure of 800 to 900 lb. kept on the fluid column in the hole.

The cuttings were thus kept in a turbulent state and had to be carried off into the formation. When the tools were pulled, the cuttings that had not gone into the cavities would settle to the bottom and 30 to 40 ft. of them would have to be drilled up after each trip before new hole could be made. This could be done until tar streaks were encountered. The tar then mixed with the cuttings and, possibly getting somewhat chilled from the water being pumped down from the surface, would form a sort of asphaltic concrete. At each change of the bit, this tough deposit would have to be drilled up and would so dull the cutting edge that only two or three ft. of new hole could be made with each bit.

The decision was then made to try to get a reversed flow of drilling fluid to make the formation pressure carry the cuttings out of the well. A back-pressure valve was designed (as shown in Fig. 1) and placed just above the bit. This valve would open when the tools struck bottom and thus allow the formation pressure of 550 lb. to force the fluid and cuttings up the drill pipe.

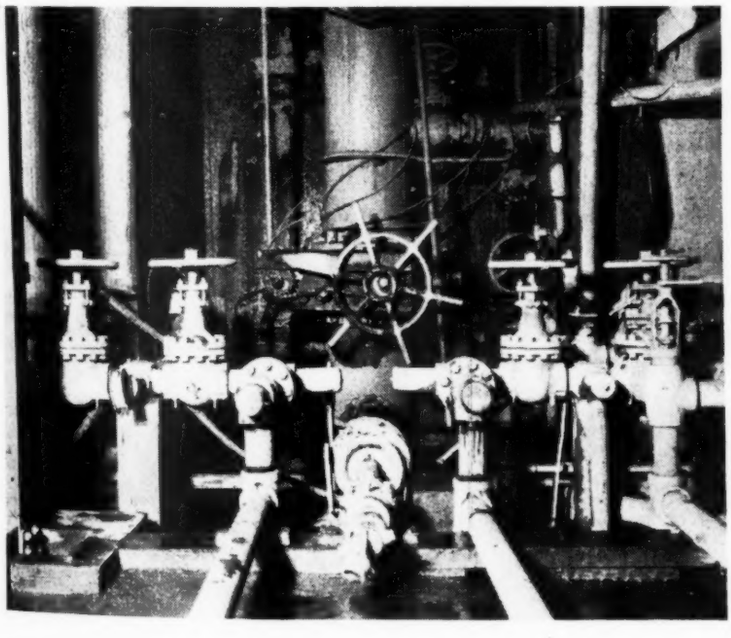
The tar came up with the cuttings and both were readily removed in a ditch. As mentioned above, the salt water could not be disposed of at the surface so, after the cuttings and tar settled out, it had to be pumped back into the casing under pressure. By this method, progress at the rate of from 30 to 40 ft. a day was made and the well drilled to 5100 feet.

Overcoming Volcanic Ash and Heaving Shale

Production in an area in Trinidad was from a fine sand that is overlain by heaving shale and volcanic ash. Well depths were from 3000 to 4000 ft. and the rock pressure ranged from 1000 to 2000 pounds. Cable tools were first used but only a negligible amount of open hole could be drilled ahead of the casing; and great difficulty was encountered in carrying casing.

Upon the introduction of rotary drilling, heavy mud was used to condition the wells. Unfortunately, the mud used would seal off the greater portion of the production and, in many cases, if the wells were permitted to flow strong enough to remove the mud sheath on the sand, the flow would loosen such quantities of volcanic ash and shale as to kill the well. Redrilling would not always bring back production.

To overcome these difficulties, pressure-drilling methods were applied. During 1927, 12 wells were here put down by pressure drilling, using a fluid so light it would not mud off the sand. In completing the wells, they were washed with water and then with oil, while the pressure on the fluid column was maintained to balance the formation pressure. The wells were put on production with controlled flow and not allowed to clean themselves. The minimum amount of the fine sand was brought up by this controlled production and it was felt that the maximum ultimate recovery would be obtained.



In the cellar of the Associated Oil Co. well, Williamson No. 1 in Lost Hills, California. Valves and gates are important factors in pressure drilling. Note the convenience of the cellar gate controls. To the extreme right can be seen an adjustable flow bean.

Prevention of Freezing

The freezing conditions encountered in the Turner Valley field are well known. In many of the wells, the gas expanding from the tight lime at the bottom of the hole reduced the temperature to minus 75 deg. fahrenheit. Rotary mud often would freeze inside and outside the drill pipe and stick the tools. Crude oil was not a successful substitution for mud because it would cut badly with the gas and was not in itself able to provide a hydraulic head sufficient to offset the formation pressure; also, the light fluid was not viscous enough to carry up the cuttings. Cable tools were slow and the strings of casing required were expensive in drilling the depths in wet hole through oil savers. The diamond-drilling equipment had the disadvantage of providing too small a hole.

A number of the rotary wells were completed by pressure drilling. With a back pressure applied, the returns were pinched in until the pressure carried on the drilling fluid equalled, at the bottom, the rock pressure. By this means, expansion of the gas was eliminated and the formation of ice prevented. In cases where hydraulic equipment was used, the control on the rock bits was so close that cuttings were so fine they could be carried out of the hole by the lightest drilling fluid.

Offsetting Highest Pressures

Probably the highest rock pressures yet encountered are in the Khaur field, Punjab, India.[1] Oil is here found at a depth as shallow as from 100 to 500 ft. and the pressures are relatively high at even these depths. Cable tool wells could not be controlled with water at depths of 2000 feet. At 2800 ft. rotary wells using 90-lb. mud could not be controlled. Below 3200 ft. the shale in open hole would cave badly with any release of pressure.

The rock pressure increased considerably below 3500 ft. and high-pressure fittings with emergency valves were installed on all wells. In some cases where casing was cemented above the high-pressure sand, production was taken through the drill pipe left in the hole.

By adding barytes, drilling fluid as heavy as 150 to 160 lb. per cu. ft. was used, but due to the salinity of water encountered in the field it was robbed of its colloidal properties. Whenever rotation was stopped, therefore, the mud and barytes would settle to the bottom and freeze the drill pipe.

Pressure drilling was first done in the Khaur field in 1932. This method, however, was used only for drilling-in the wells, and as only one bit was required for the job, no snubbing-in equipment was provided. The drill pipe was 2⅞-in, 3½-in. or 5-in. flush-joint equipped with one or more back-pressure valves. The string was tested from 2000 to 2500 lb. when the bit reached bottom, and after drilling started the pressure at the beaned discharge lines was kept at about 500 pounds.

As soon as gas was struck, the control pressure was increased by means of smaller beans until a pressure balance was obtained with the well neither making nor taking fluid. When the total depth was reached, the bit was raised while the full pressure was held on the well. Usually the well was brought in through the annular space between the drill pipe and casing by opening one or more beaned lines and shutting down the pumps.

In this field, the pressure applied is that which will prevent fluid from entering the well from the formation. At depths of 4800 to 5300 ft. the control pressure is usually from 2000 to 2300 lb. with 85- to 95-lb. mud. In a deep test made in 1934, the well alternately extracted water from the drilling fluid or added to it from the formation as the controlled pressure was raised or lowered.

A string of 5-in. flush-joint drill pipe was used for the pressure-drilling operations in this deep test and was snubbed-in with snubbing equipment made up on the job. Under the pressures encountered, it was necessary to snub from 2000 to 3000 ft. in and out of the hole at each round trip. The well-head control equipment through which the pipe passed consisted of, from top to bottom: drilling head complete with hydraulic bag packer fitted below the drilling packer; mud cross; control gate with 5-in. drill pipe rams; a 15-ft. length of 8⅝-in. casing as chamber for drill collar and bit; control gate with 5-in. drill pipe rams; master valve; control gate with blind rams; and mud cross. The arrangement is shown in Fig. 2.

At 5693 ft. a string of 7-in. flush-joint casing was run to cement off the 5100-ft. and 3300-ft. sands. A suitable blow-out preventer was substituted for the drilling head and the top control gate was fitted with rams to close against the 7-in. casing. The casing was snubbed-in under a bean pressure of from 2000 to 2400 pounds. It was fitted with two float collars. At a depth of 3500 ft. the casing balanced the well pressure but it had to be snubbed through the blow-out preventer to about 4200 feet.

During cementing, the bean pressure was gradually reduced to 1500 lb. in order to increase the pumping speed and place the cement in position rapidly. After the cement job was completed a pressure of 2250 lb. was put on the outside of the casing to balance that on the inside. These pressures were left on the well while the cement was setting.

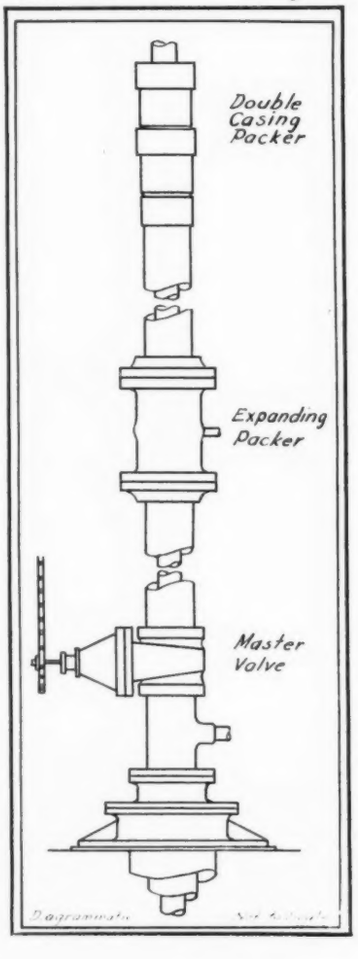


Fig. 3. Arrangement of cellar control fittings used for pressure drilling in the Lincoln-Getty well in Lost Hills, California.

Shutting Off Zones of Different Pressure With One String of Casing

In California, pressure drilling has often been used to overcome difficulties encountered in drilling through high-pressure zones where operations could not readily be controlled by other means. An interesting example of such an application was on the Lincoln Drilling Company well No. 1, which was later called the Getty No. 1A, in the northern end of the Lost Hills field.

This well had been drilled to a little more than 2000 ft. and a string of 11¾-in. casing was set at 1919 feet. The original plans provided for drilling through 8⅝-in. casing with an expanding bit and underreamer while carrying the casing in suspension on an hydraulic rotary table set on the cellar floor. The object of such procedure was, of course, to prevent caving or heaving shale by confining the formation behind the casing as the

[1] A complete description of the operations in the Khaur field is given in a paper on "Drilling Against High Pressures in the Khaur Field, Punjab," by C. E. Keep, M. Sc., and H. L. Ward, Attock Oil Company, read at the October meeting of the Institution of Petroleum Technologists in London. The brief summary of operations here given is from data contained in this paper.

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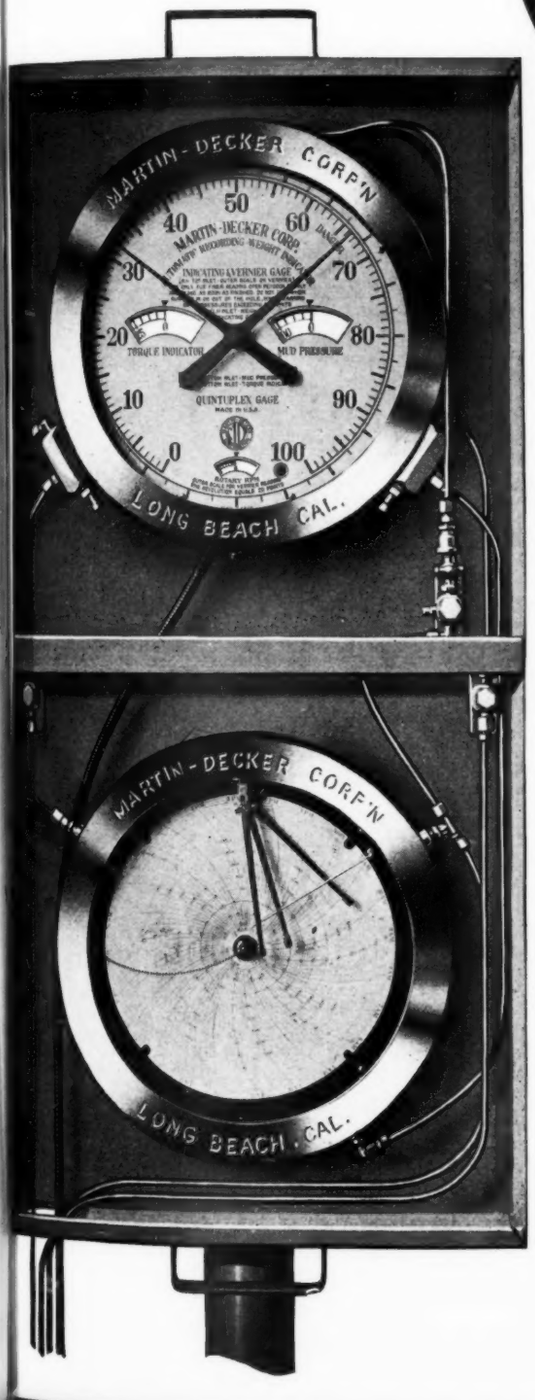

"Quintuplex" is a composite instrument composed of five individual units, each providing the driller with information on a different phase of the drilling operation. One instrument shows weight on bottom and load on the derrick. A third extremely sensitive instrument shows slush pump pressure. A fourth shows torque in the drill pipe, and a fifth the speed of the rotary table.

The "Quintuplex" with its combination of instruments unfolds before the driller's eyes, every action, every change, every condition as it actually occurs during drilling progress.

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hole was being drilled. By applying pressure-drilling methods, however, this procedure was found to be unnecessary.

The cellar was first dug deep enough to accommodate the necessary valves and control fittings. Weight material was then added to the mud to hold back a heavy flow of water while the tools and drill collar were pulled out. With these removed, a casing plug was inserted into the 11¾-in. string in order to hold the pressure until the valves and other cellar fittings were installed.

The pressure control fittings, as indicated in Fig. 3, consisted from top to bottom of: a 5-in. drilling packer; a drill collar packer immediately below the drilling packer in the same body; a chamber for extraction of the tools, in the middle of which was an expanding packer; a master valve; and a mud outlet. The rotary table used for the operations was hydraulic. With the fittings installed, flush-joint drill pipe was run in, the casing plug was released and pulled out and a drilling bit run in to clean out the hole.

The casing was then filled with salt water and the pressure at the derrick floor found to be 600 pounds. By maintaining a pressure slightly in excess of the formation pressure it was found possible to drill either with water or with mud fluid and yet have no trouble from caving or heaving shale. About 400 ft. of 10¾-in. hole was thus drilled with water and thin mud used for circulation.

A leak was here discovered and found to be caused by an imperfect joint in the 11¾-in. casing, which discharged between the 11¾-in. and 18⅝-in. casing. This leak was plugged with cement. For some reason, however, the drilling out of the cement was apparently done with little or no back pressure on the overflow, for as soon as the bit passed through the cement a sudden flow of water carried shale up into the casing above the bit and drill collar.

The pipe was immediately pulled up and jammed in the shale that surrounded it. According to some, the pipe should have been kept rotating and lowered with water circulated down the annular space between the drill pipe and casing to dislodge the shale with the object of forcing it into the water course of the formation. Later events showed that this could have been done, but since a hard pull was taken on the pipe it became wedged too tight for any downward movement and necessitated a washover and backing-off job.

Attempts were then made to cement and plug off the water stratum. These were not successful nor were any satisfactory results obtained from plugging with heavy weight material. Drilling was therefore continued with the water entering the hole.

The rate of drilling then ranged from 75 to 100 ft. per day. After several hundred feet of hole had been made, the pressure increased about 150 lb. and indicated a higher pressure zone had been penetrated. A gasket blew out of the gate valve at this time so the casing was plugged and a new high-pressure valve with other high-pressure fittings were installed.

When about 1700 ft. had been drilled and cored, the pressure suddenly increased another 190 pounds. Weight material was then used in an attempt to lower this pressure, but it continued to build up until it reached 1300 lb. at the surface.

The decision was therefore made to set a string of 8⅝-in. left-hand, flush-joint casing and the procedure followed is shown graphically in one of the illustrations. To do this, a high-pressure plug was made and set near the bottom of the 11¾-in. casing. The drilling packers were then removed and replaced with casing packers. The 8⅝-in. casing was equipped with a suitable shoe for dislodging the casing plug and forcing it ahead as the string was run.

The casing was also equipped with two expanding packers (the upper one lead and the lower one rubber), which were so spaced as to be at points in the hole where cores and the well log had indicated solid formations. Side outlet valves were placed above each packer and so designed that they would discharge a portion of cement against different external pressures. Cast-iron back-pressure valves were located in the casing just below the outlets. The packers were separately tested under a pressure of 2000 pounds.

The casing was run in the usual manner to a point just above the plug in the 11¾-in. casing. The 8⅝-in. casing was filled with mud and mud was pumped into the 11¾-in. casing to discharge through the plug and equalize the pressure above and below that plug. The pressure was found to be a little over 1000 pounds.

The casing was then lowered down on top of the plug and, continuing down the hole, carried the plug ahead of it until the bottom was reached. By rotation of the casing to the left, the lower rubber packer was expanded first; this was followed by expansion of the upper lead packer. As soon as these were set, the gauge indicated that the high-pressure zone at the bottom had been sealed off from the annular space between the 8⅝-in. and 11¾-in. casings. This cut off circulation between the very high-pressure zone and the lower-pressure zones and put the hole in good condition for cementing.

Snubbing equipment was naturally used on this operation for running pipe in and

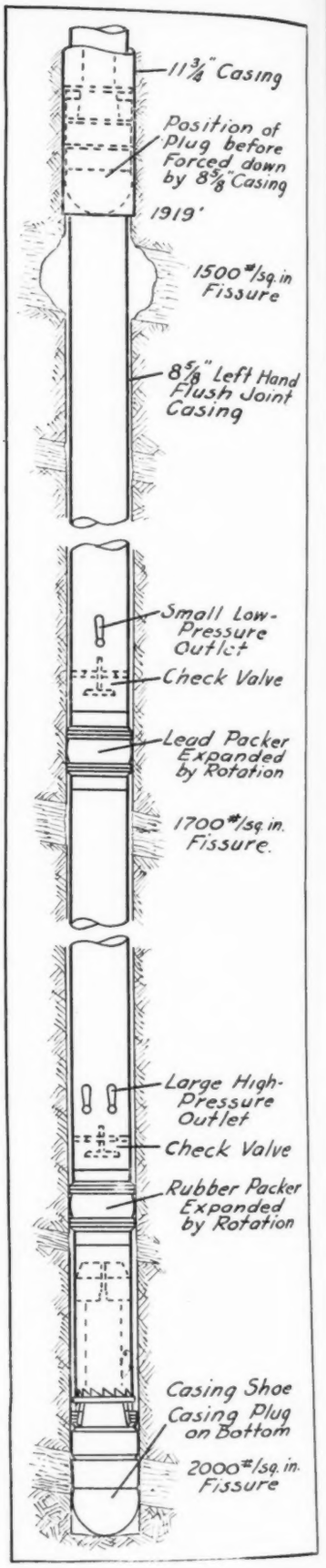


Fig. 4. Method used for cementing off zones of different pressure with one string of casing.

out of the hole. The type employed is shown in the accompanying illustrations and was equipped with double-acting automatic slips. While drilling and running in and out with 5-in. drill pipe, it was necessary to pull in and snub out from four to 16 stands, depending on the well pressures and weight of the fluid.

Recovering Control of High-Pressure Well

While not strictly a pressure-drilling operation, the use of pressure-drilling equipment has been found advantageous in killing producing wells flowing under high pressures. The procedure is exemplified in the recovery of control of the discovery well in the North Dome of Kettleman Hills, details of which have been presented in a previous number of *The Petroleum Engineer*.[2]

This well, Milham Exploration Company Elliott No. 1, was producing about 1200 bbl. of oil and 52 million cu. ft. of gas per day at the time it was killed. Production was through 6⅝-in. casing and around a string of 3½-in. drill pipe that had stayed in the hole when the well blew in. The well connections were more than 20 ft. above the derrick floor and, since they could not be disturbed, a platform was erected above them.

An hydraulic rotary was installed on this elevated derrick floor, about 30 ft. above the original floor. Drawworks and engine were located at the normal elevation but all controls were on the platform. The snubbing equipment consisted of a line-operated yoke with automatic slips, as illustrated.

Above a valve on the 11-in. casing was placed an emergency packer, on which was a short nipple and a double packer, or drilling head. The latter was for use in running flush-joint drill pipe into the hole under pressure and the emergency packer provided a means for changing the top packer while the pipe was in the hole if such should become necessary.

The well pressure was 1300 pounds. A string of 3½-in. flush-joint drill pipe equipped with a standard pin was run in under this pressure. The first 60 ft. was forced in with the hydraulic table because of the better control it offered. The rest of the string was snubbed in with the pull-down yoke until its weight overcame the pressure.

At 1700 ft. the top of the old drill pipe was encountered but attempts to catch it with the standard pin were unsuccessful; so the pipe was pulled, an impression block run, and a special pin constructed and run in on the flush-joint drill pipe.

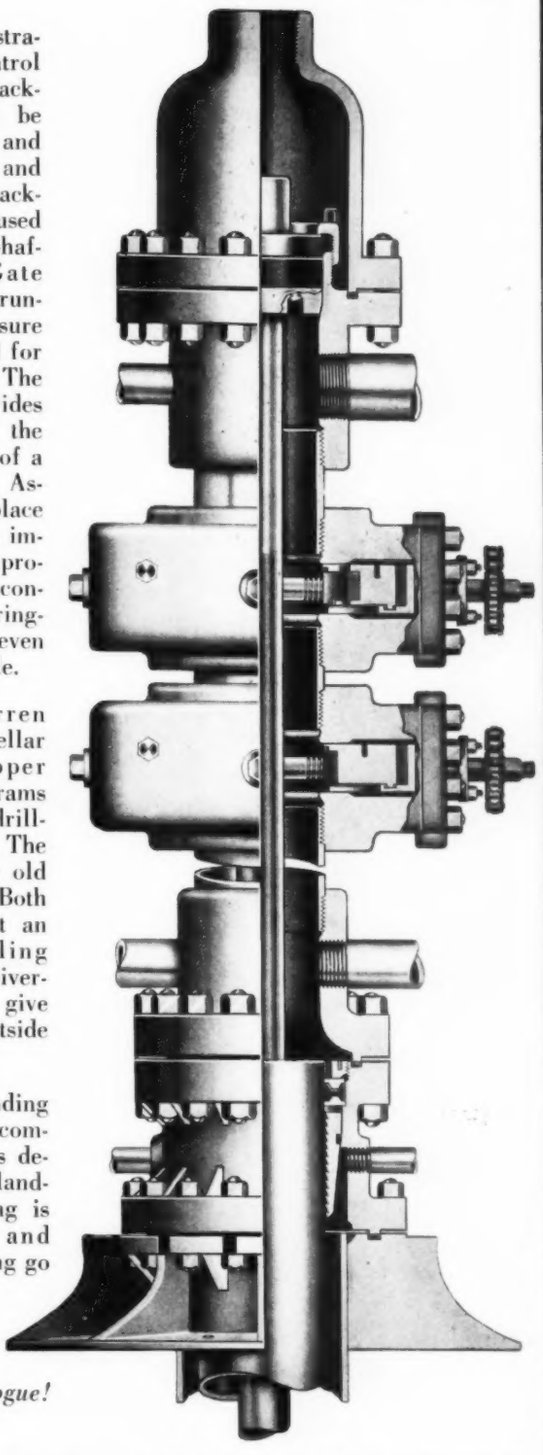
[2]See "Killing the Kettleman North Dome Discovery Well," *The Petroleum Engineer*, September, 1931.

Prevent Trouble!

At the top of this illustration is the Warren Control Head which carries a packing assembly that can be quickly thrown around and latched on the drill pipe and dropped in place. The packing assembly may be used in connection with the Shaffer Cellar Control Gate (shown just below) for running tubing under pressure or the head may be used for landing the oil strings. The Christmas Tree cap provides a rigid foundation for the Christmas Tree. In case of a blowout the Packing Assembly may be put in place and the Christmas Tree immediately attached. This provides quick means for controlling the well and bringing it into production even if drill pipe is in the hole.

Just below the Warren Head are two Shaffer Cellar Control Gates. The upper gate is provided with rams to pack off around the drill-pipe, casing or tubing. The lower gate replaces the old style drilling valve. Both Gates make as compact an assembly as one drilling valve alone. Shaffer Universal Joint connections give remote control from outside the derrick.

The Spool Type Landing Head and landing base complete the assembly. This device is the last word in landing casing as the casing is supported by slips and packed off without letting go or cutting nupples.



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Connections were then made with the old string of drill pipe and, after testing, water was pumped to the bottom of the hole. The water killed the flow but was later replaced by mud. The well, however, was under control and the old drill pipe was easily pulled out.

Control of Drilling Fluid

In pressure drilling, as well as in any kind of rotary drilling, due consideration must be given to the mud or circulating fluid. The use of admixtures must be governed by conditions and although the overcoming of formation pressure does not depend on the weight of the fluid column, the character and conditioning of the drilling fluid is important. There are times when drilling through a high-pressure zone that a balance of pressure is clearly indicated by the character of the mud. When the pressure applied exceeds that of the formation, water may leave the mud to such an extent that the mud becomes unpumpable; or when pressure is relieved, a formation water under high pressure may thin the mud to an excessive degree.

Different types of formations naturally need different treatment. There is a probability that chemicals may be found advantageous for use in connection with pressure drilling and may often assist greatly in keeping heaving shales and caving under control. Yet in some cases in California caving has been avoided by merely keeping the pressure on the formation; also, water alone has been used to prevent caving by pumping into the formation and allowing only enough returns to bring up the cuttings.

With pressure drilling, there must be a balance of pressure, which may be from 100 or 200 lb. up to whatever the conditions require. The back pressure is controlled by restriction of the return line or lines, for which purpose flow beans have been found valuable. The cutting of the beans by abrasive cuttings, especially under high pressure, has naturally led to the use of hard-facing metals for the exposed surfaces and to designs that will prolong the life of the beans.

Equipment for Pressure Drilling

In general, the equipment necessary for pressure drilling must provide a snubbing device for running the drill pipe or casing while pressure is on the well; a stuffing box head that will provide for lowering and raising the pipe and for rotation, and at the same time maintain pressure by sealing the annular space between the set casing and the drill pipe or casing being run; control gates that will pack-off around the pipe being run; one or more master gates or valves; a chamber to permit the insertion or removal of the bit, drill collar, and tool joint without dissipating the pressure; and mud outlets for the returns and for pumping in mud to replace the pipe with fluid and maintain the pressure when necessary.

There are, of course, various arrangements of the equipment. The hook-up used on the Punjab high-pressure well is somewhat general and is shown diagrammatically in Fig. 2.

Flush-joint drill pipe will undoubtedly become popular with pressure-drilling methods. It facilitates the operation and saves time on every trip. It is erroneous, however, to say that pressure drilling cannot be done with collared drill pipe; but the advantage of flush-joint is self-evident.

The hydraulic feed, used either in conjunction with, or forming an integral part of, the rotary table also has advantages that are evident. There is no doubt that close control of the type that is eminently desirable in pressure drilling can be obtained with the hydraulic, for together with the use of flush-joint drill pipe and flush-joint casing, it probably gives the greatest range of mechanical operation.

A back-pressure valve should be placed in the drill pipe above the bit or drill collar for pressure drilling. This will prevent the well flowing through the drill pipe while going in or coming out of the hole. When running casing, either two float collars or a float shoe and float collar provide this feature. The running of casing into a well under pressure can be done in a manner much like that cited in the Punjab well. Aside from the requirement of snubbing until its weight overbalances the pressure, the procedure is about the same as in regular rotary practice.

Various types of equipment that have been developed for drilling through high-pressure zones will be given in an article to appear next month.

Removing Oil From Water

ALTHOUGH the emulsions encountered in the production of crude oil are usually of the water-in-oil type, it is interesting to note that the shipping industry is bothered with emulsions of the reverse type. These oil-in-water emulsions are formed when sea water is pumped into empty fuel oil tanks for ballasting purposes.

Severe restrictions govern the dumping of oil-contaminated ballast water in territorial waters and harbors, and the problem of ballast water disposal is becoming more acute with the increasing use of heavy oils as fuel. These heavy fuel oils serve to form very stable oil-in-water emulsions, which are difficult to separate due to the fact that the specific gravities of both phases are so nearly the same.

An investigation of means to overcome this problem was begun about two years ago with the result that an entirely new type of separator has been developed. An experimental unit installed on a barge at Port Los Angeles, California, has satisfactorily met the requirements of ships discharging ballast water there. After some further development work the process will be made available at other ports.

This new method of separation may also prove useful in the disposal of oil-contaminated waste waters from refineries.

THIS PATENTED SWAB *has 9 ADVANTAGES*

Because the GUIBERSON Swab operates on an entirely different principle from other swabs, and is patented—it offers the operator no less than *9 fundamental advantages* which are strictly *exclusive* to this swab.

So apparent have its advantages been, ever since it was first placed on the market, that for many years it has done considerably more than half of all swabbing, throughout the world.

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BETTER BE SAFE THAN SORRY

Control of Colloidal Properties Are Vital in Mud Conditioning

By WALLACE A. SAWDON
Petroleum Engineer, Los Angeles

THE development of drilling technique has undoubtedly been accelerated by the necessity for deeper wells; and it has resulted in safe and efficient methods for meeting any conditions yet encountered. Mud control is an important factor of this modern drilling technique; yet while it is so important in deep drilling and in overcoming high pressures, the conditioning of the drilling fluid is fully as necessary in wells of any depth. In fact, aside from pressure control by weight, the control of the colloidal content of a mud fluid is probably more important with many low-pressure subsurface conditions; and it may influence the ultimate yield of a zone as well as facilitate the penetration to and in that zone.

The functions of a good drilling fluid are, in general: (a) to remove cuttings from the well; (b) to lubricate the walls of the hole, the drill pipe, and the mud pump; (c) to provide a means of holding solids in suspension while circulation is stopped; (d) to seal up formations against water penetration; (e) to prevent sloughing and caving under certain conditions; and (f) to provide a fluid head that will exert pressure on formations that would otherwise force water, gas or oil into the hole. The removal of cuttings, the lubrication and the suspension of solids are all functions of the colloidal properties of the fluid. The sealing action and prevention of sloughing or caving are mainly derived from the colloids but may or may not be assisted by pressure. The fluid head is, of course, obtained by weight alone; but if the fluid is to function in drilling operations, some amount of colloidal material must be present to meet other necessary requirements besides that of weight.

Under average drilling conditions, there is, in general, a percentage of colloidal material that will give consistently good results. Certain formations, however, may necessitate a change in this percentage and a well may require a fluid of varying colloidal properties as it progresses. While this factor may in itself necessitate close attention to the character of the fluid, it must be remembered that even where formations may remain the same during the entire depth of a well, the character of the fluid is constantly being changed by the cuttings that are carried up by circulation. Mud conditioning is therefore desirable under the best conditions; and is often so necessary that it will be a factor in the success or failure of the operation.

Colloidal Properties

Colloids are substances so small that their mixture with water closely approaches a true solution. Their suspension is almost complete and they settle out so slowly that they can be considered as being in solution as far as the time required for drilling operations is concerned. A good colloidal mixture will form a gel when not in motion and will return to a fluid state when agitated. This property in a drilling fluid, therefore, provides a means of holding solids in suspension when circulation is shut down and allowing their easy flow to the surface when circulation is resumed.

It is the colloidal matter in a drilling fluid that provides the plastering of the walls. A fluid containing only colloidal particles will, moreover, form a plaster of minimum thickness, and as the percentage of other solids increases, the thickness of the plaster increases. As illustrated in an accompanying sketch, the thickest plaster is composed of the greatest number of non-colloidal solids encased with a minimum of colloidal matter.

Colloidal suspensions have a high viscosity for a low percentage of solids. Yet a highly viscous fluid may not necessarily be rich in colloids, since the viscosity is based on the shearing strength of the physical mixture. A mud fluid composed of a large amount of quickly settling solid matter can have a viscosity so great that the pumps will not handle it and yet have little or no colloidal properties.

There is no question about the value of plastering the walls of a hole to prevent water from entering a formation. When the producing zone is so plastered, it is admitted that the mud sheath

A complete mud-testing laboratory is set up at the well with this equipment. Here the various instruments, carried in the back of a coupe, are shown ready for use

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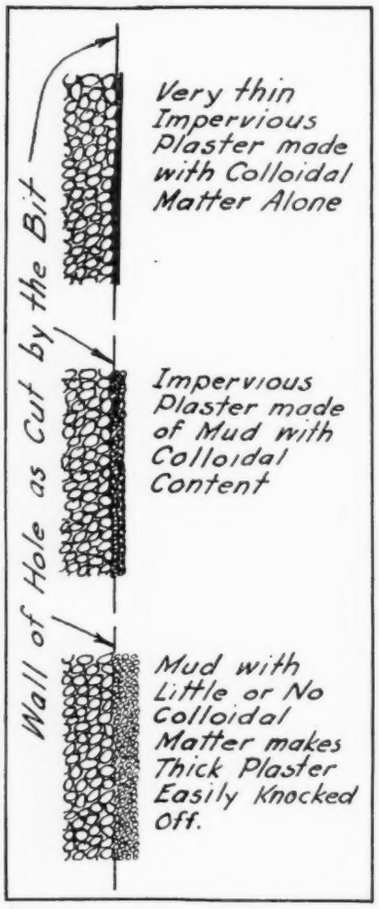
Very thin Impervious Plaster made with Colloidal Matter Alone
Impervious Plaster made of Mud with Colloidal Content
Mud with Little or No Colloidal Matter makes Thick Plaster Easily Knocked Off.
Wall of Hole as Cut by the Bit

Effect of colloidal matter in rotary drilling fluid. (Formation exaggerated to give contrast.)

must be thoroughly removed before the well is completed; but except in cases where such removal is impossible (and it is doubtful if means are not available for removal in any case) the value of the mud plaster in keeping water out of the sand is evident. The distance to which water will penetrate a sand depends on the porosity, the differential between the pressure on the fluid column and the formation pressure and the length of time the water is permitted to enter.

The greater the colloidal content the quicker will be the formation of plaster and the thinner will be the mud sheath necessary to stop infiltration of water. In wells where the diameter is small, any area deducted from the annular space between the drill pipe and the wall of the hole means that much less space for circulation returns. The thicker the plaster, moreover, the easier it is to knock it off, especially since a thick sheath of mud contains more solids encased by a thinner bond of colloids.

The percentage of colloidal matter in a drilling fluid must not, however, be too high. If it is, it will not let the cuttings settle out. About five per cent is probably the satisfactory amount under average conditions. Except for providing weight to the fluid column where it is necessary in overcoming formation pressure, non-colloidal solids have no value. Drilling fluid can therefore be made with a strictly colloidal admixture and water without the use of native mud. Some of the companies in California are using such fluid, which offers the advantage of not having any useless solid matter to start with and requiring conditioning only for contamination caused by drilling.

Mud Tests

Many of the larger operating companies in California are now making tests on the drilling fluid at periodic intervals during each tour. Tests for mud weight are made with a hydrometer and tests for viscosity with a funnel viscosimeter. Samples for the tests are taken from both the discharge and suction in order to determine the character of the fluid before and after circulation. The viscosity measured by the funnel is close enough for practical purposes at the well but in order to get an accurate determination of the true viscosity, check tests are made at regular intervals with a Stormer viscosimeter.

To assist operators in determining the properties of their drilling fluid, the Baroid Sales Company has recently equipped a fleet of cars with apparatus by means of which a rather complete test can be made in the field. As can be seen from the accompanying illustration, each car is virtually a mud-testing laboratory that can be put into immediate service at a well.

Separate tests are run on samples from both the discharge and suction. The weight is determined in lb. per cu. ft. and lb. per gal. and the specific gravity recorded. Both the Marsh funnel and the Stormer viscosimeter are used for measuring the viscosity, that by the former being read in centipoises and the latter in 500 cc. seconds. When desirable, the gel strength is measured and either the alkalinity or acidity of the fluid given in ph units. The temperature is read in deg. fahr. and the salt content is determined in percentage by weight.

In the determination of solids in the drilling fluid, the weight of the contained solids is read in grams and the volume in cc. while the percentage of solids is given both by weight and volume. As will be noted in the illustration, the car laboratory is equipped with a hot-plate for evaporation. The plate is heated by electricity, which is made available by a generator set driven by the car's motor. The picture shows the apparatus set up for testing at the well but the arrangement is so compact that all instruments, equipment, and supplies are easily contained in the rear of the coupé.

Vicosity is again measured after treatment, and a complete screen analysis of the mud samples is made for percentage retained on 80-mesh and passing through 80-, 100-, 150- and 200-mesh screens. The settling test gives the per cent by volume of clear water after standing. The colloidal content of the mud is also measured.

Conditioning of Drilling Fluid

By systematic testing, a mud can be kept in a condition that will aid materially in making the drilling operations efficient. In drilling the deepest well in the world, Berry No. 1 in the South Belridge field, California, the General Petroleum Corporation believe that the careful measurement and constant control of the mud properties were an important factor in the success of the job. The mud was passed through a vibrating screen during the entire drilling and this was felt to have been a great help in minimizing stuck drill pipe, in reducing mud replacement, and in decreasing the wear on pump parts.

The colloidal matter in a mud will aid in preventing excessive abrasive action of fine particles. The vibrating screen, however, has been found of particular advantage in thoroughly removing solids that will reduce the life of pumps,

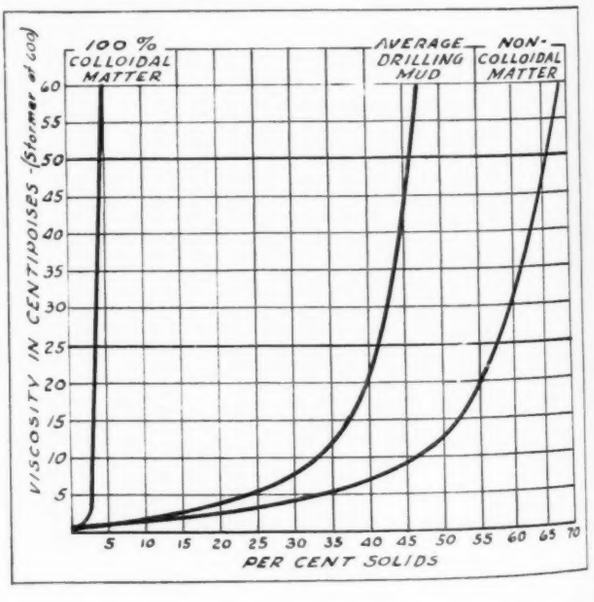

Chart showing viscosity-solids percentage curves for colloids, average drilling mud, and non-colloidal matter

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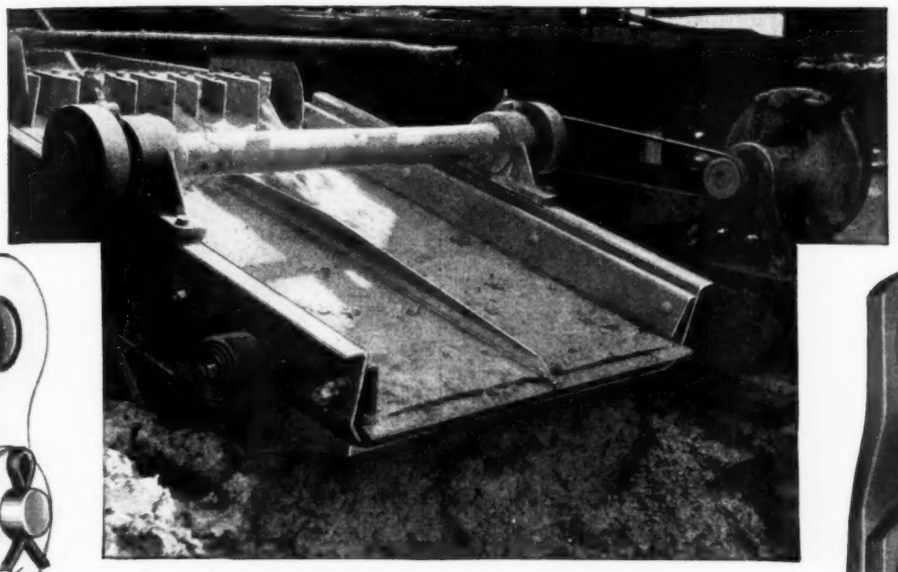
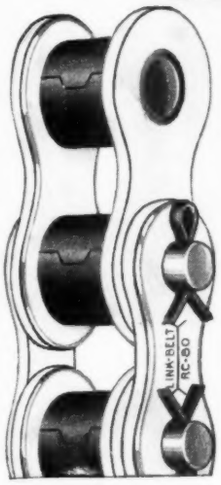
ROTARY CHAINS and ROTARY MUD SCREENS





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Single McNeely vibrating screen installation on General Petroleum Corporation well, Tonner lease, Brea, California. The screen is situated directly in front of the flow pipe, and the suction pit is just to the rear and below the screen. Thus the total length of the mud ditches is less than 15 feet

valves, fittings, and drill pipe. The settling ditch can, of course, be shortened when using the vibrating screen, which when properly handled should save a considerable amount of replacements of mud and admixtures.

Gas-cutting, of course, necessitates added attention to mud control. When going through a formation where gas is released, drilling will usually be slowed down and it will often be advisable to circulate for an hour after rotation is stopped before pulling the tools from the hole. This will reduce the percentage of gas in the fluid and will allow time to plaster the face of the formation. It will also reduce possibilities of gas accumulation, which, although remaining in equilibrium while standing quiet, may cause a blow-out when agitated by the tools entering the hole.

If gas goes into a simple mixture with the mud or is absorbed by the fluid, it will usually escape when brought to the surface. If it is adsorbed on the surface of or in the pores of the solid, its removal is more difficult. The vibrating screen has been found to aid considerably in getting rid of gas but even the screen or aerating cannot always remove gas that has been adsorbed by the solids. This adsorption is done under pressure and with certain kinds of gas but will cause gas-cutting of the fluid if put back into the well.

In drilling through gas zones, it is probably better to reduce the colloidal property to just enough to return the cuttings and prevent settling of solids in the hole. Bit control can provide fine cuttings that are easily brought up the hole with less chance of gas adsorption.

To overcome heaving shale or prevent caving or sloughing, the colloidal content of the fluid must be greatly increased. Individual conditions govern the treatment, and the addition of other materials is sometimes necessary.

Weight Materials

The use of weight materials has become general practice in meeting many high-pressure conditions. Weight control then becomes a definite factor in mud conditioning but does not eliminate the necessity for supplying proper colloidal properties to the fluid. In fact, control of the colloidal content of the mud and its viscosity are even more important when using weight material than when using native mud.

Colloidal Admixtures

The use of admixtures (consisting almost entirely of colloids) and water instead of natural mud has become a practice with many of the operating companies. The fluid thus made usually weighs about 64½ lb. and compares with natural

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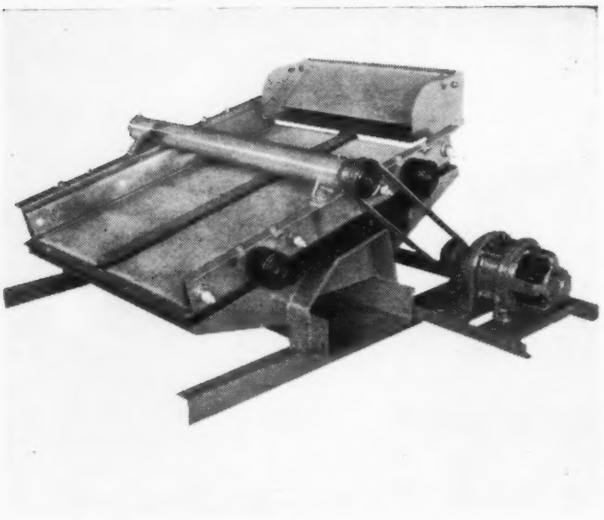

Latest design of the Link-Belt rotary mud vibrating screen for desanding drilling mud

mud weighing from 72 to 75 lb. per cubic foot. Cost comparisons of the two types of fluid take into account that the average natural clays in California will make about 20 bbl. of mud fluid per ton and that the concentrated colloidal admixture (specially treated bentonite such as Aquagel) will make from 120 to 180 bbl. of drilling fluid, depending on the percentage desired.[1]

When natural muds are used, the colloidal property is frequently added and it is the usual custom to condition the mud with the admixture. The chief function of weight in mud is only to provide fluid column pressure. Greater attention is now being paid to keeping the fluid in a condition best suited to meet drilling requirements.

Viscosity is therefore a factor in mud control and should be carefully watched. A mud pump will probably handle a fluid with a viscosity of 30 centipoises or above, but such a fluid will hardly drop out cuttings with any degree of satisfaction.

After drilling, trapped solids taken from the formation will add weight to the fluid. Proper settling out of these solids should be disclosed by a comparison of tests taken on samples from the discharge and suction. As mentioned above, periodic tests should be made of the weight and viscosity of the fluid and all data available applied to aiding in the conditioning of the fluid.

The degree of influence on the drilling fluid caused by high temperatures has never been well determined. Very high temperatures have been encountered in some of the California wells but the conditioning of the mud has been based on the temperature at the surface. In the well cited above, Berry No. 1, the temperature at 9600 ft. was 216 deg. fahrenheit. From this it was estimated by projecting the temperature curve that the temperature at 11,000 ft. was 310 deg. fahrenheit. The mud conditioning on this well was carefully controlled, however, and the results obtained were excellent.

[1] *Editor's Note:* Some of the well-known mud-conditioning and mud-weighting products in use are:

COLOX—Geo. S. Mepham Corp., East St. Louis, Illinois.
OPALITE—Corona Products Inc., Rogers, Arkansas.
AQUAGEL—Baroid Sales Company, Los Angeles, California.
MUD WATE—The Sullivan Company, Memphis, Tennessee.

A partial list of manufacturers of mud-conditioning equipment:

VIBRATING SCREENS—Vernon Tool Company, 2740 East 37th Street, Los Angeles, California (McNeely Vibrating Screen).
Link-Belt Company, 910 South Michigan Blvd., Chicago, Illinois.
Shaffer Tool Works, Brea, California.
CLASSIFIERS—Dorr Company, 247 Park Avenue, New York City, N. Y. (Used in central mud-conditioning field plants.)
CENTRIFUGAL SEPARATORS—Merco Centrifugal Separator Company, Ltd., 343 Sansome Street, San Francisco, California. (This separator is used for desanding rotary drilling muds and also for reclaiming mud-conditioning materials.)

George A. Spang Passes Away

George A. Spang, well-known manufacturer of oil-drilling tools, president of the firm of Spang & Company and till 1932 its active business head, died at his home in Butler, Pa., January 22. He was 66 years old.

GEO. A. SPANG

After leaving school, Spang became an apprentice in the machinists' trade at a shop in Pittsburgh, and upon completing his apprenticeship he returned to Butler, obtained a position as a machinist, and was married. He was employed for a time in Cleveland, Ohio, but returned to Butler soon enough to be on the ground when the drilling excitement of 1894 started, centering in the Cooperstown district between Butler and Pittsburgh. He set up a shop for the service of drilling contractors. From Cooperstown, the tool shop was moved to Renfrew, Pa., and enlarged. It was in 1899 that Spang made his final shift of location, returning to Butler.

Packers were just beginning to be commonly used. Spang, with others, was responsible for improvements in design and took out several patents that proved valuable. Packers became one of his principal items of manufacture. Later he developed a method by which drilling and fishing jars, previously made by a welding process, could be forged as units, each from a single piece of steel. Weldless jars, therefore, became an important part of the company output.

Branch warehouses and shops were established by the company from time to time in Kansas, Oklahoma, Indian Territory, Texas, West Virginia and Michigan. During the World War production was diverted to the making of shells but was turned again to oil well requirements as soon as possible.

For the last two years, due to poor health, Spang had been unable to take any very active part in the business, one of his sons becoming general manager and all his varied responsibilities being more and more taken over by one and another of them or by other associates.

Three sons, his widow, and one daughter survive him.

W. A. Chaney Resigns, Succeeded by L. J. Nelson

W. A. Chaney has resigned as manager of the East Texas district for International Supply Company to accept a position with the Hercules Supply Company as Gulf Coast district manager. His headquarters will be at Refugio, Texas. L. J. (Nellie) Nelson succeeds Chaney with the International, his headquarters being at Tyler, Texas.

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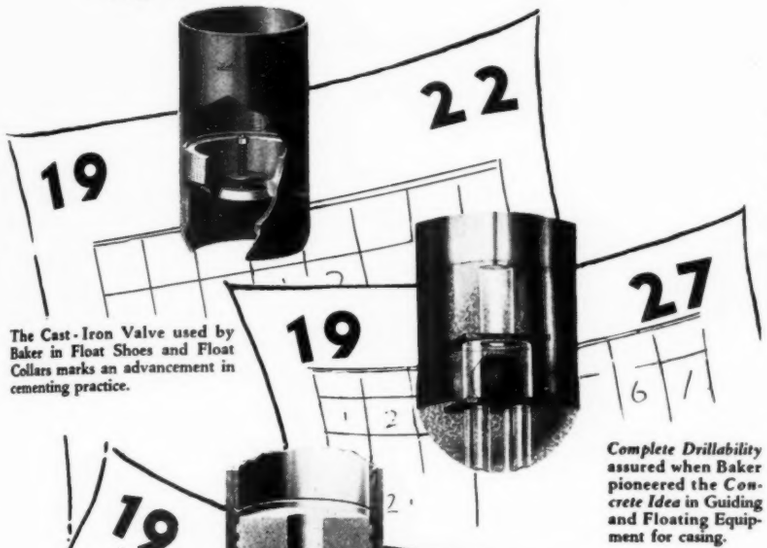

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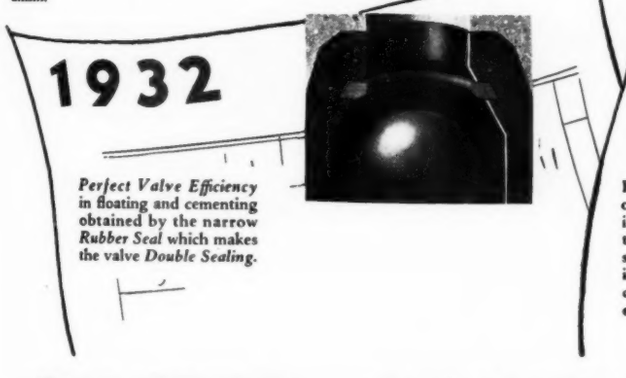

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Since the introduction of the Baker Pattern Casing shoe in 1907 Baker has led in the timely development of practical and efficient casing guiding, floating and cementing equipment. It is to be expected that Baker should continue to lead. For more than 27 years Baker has studied the changing needs of the oil industry for safely landing and cementing strings of casing, has concentrated on solving the problems presented by the trend to deeper drilling. As a result Baker Cement Equipment today represents the best possible combination of the three essentials for the safe and proper guiding, floating and cementing of casing strings of any length: Strength — Valve Efficiency — Drillability.

The future will bring demands for new tools to meet new requirements. Accepting its responsibility as a leader, Baker will always strive to anticipate all practical demands with essentially useful, efficient, *field tested* equipment as it has done since the pioneering days of 1907.

In most cases the fine fragments of concrete and Bakelite are readily distinguishable to show when the plug has been drilled through. However, as some operators desired a special "indicator" for use in certain localities, Baker in March of 1934 placed in the field Cement Equipment with the plug made of RED concrete. The coloring used in no way affects the essential qualities of the concrete, and this equipment is available at no extra cost.

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W. L. NELSON
• K. C. SCLATER •
Editors

Elements of Applied Petroleum Production

Article 17

CENTRAL PUMPING POWERS

By K. C. SCLATER

THUS far, in discussing the application of power to pumping wells, we have considered only individually-powered wells; that is, beam-pumping wells or wells equipped with individual pumping units.

There are many other wells that are pumped in groups from a central power plant. Central powers are used to pump wells of the type that, because of power requirements and their being close together, can be pumped more economically in a group. Most of the small wells in shallow fields are pumped from central powers.

Pumping of wells in groups is known as multiple pumping. The central power plant is known by various names, such as a central power, a pumping power, or a jack-pumping plant.

A central power consists essentially of a prime mover and some type of power transmission. Shackle lines convey the necessary power and desired reciprocating motion from the central power to the wells. A pumping jack at each well converts the horizontal motion of the shackle line to a vertical motion at the polished rod.

The method of pumping wells from a central power has been in use for fifty years or more in the fields of Pennsylvania. The small shallow wells in that region were well adapted to this method of pumping.

There are three general types of central pumping powers, namely:

Push-and-pull powers,
Bandwheel powers,
Geared powers.

There are also other methods for pumping a small group of, say, two, three, or four wells. They are:

Pumping two or more adjacent wells by means of a pitman attachment on a beam-pumping well.

Pumping two or more adjacent wells by means of a back-side crank on a well having an individual pumping unit.

Two other systems have recently been developed for multiple pumping. They employ a central power plant, but differ from the regular type of central power in having auxiliary power units instead of jacks at the wells. The auxiliary unit at the well obtains its power from the central plant. One of these systems uses a pneumatic head as the auxiliary well unit; the other system uses a small electric pumping motor. In the former, air or natural gas is compressed at a central plant and piped to the well. A system of lines connecting the discharge pipes from the pneumatic heads returns the air or gas to the central plant to be recompressed.[58] In the system where electric motors are used at the well, the electric power is generated at a central power plant on the lease.[74]

The typical modern pumping power is of sturdy all-metal construction and is designed for economical service. Wells 4000 ft. in depth are being pumped today from central powers. Thanks to improved design and construction.

PUSH-AND-PULL POWER

This type of central power was among the earliest to be developed. Although still in general use it is gradually being replaced by powers of a more modern type. George[52] describes this type of central power as follows:

"It was made mostly of timber with wooden pull wheels and two- by four-inch main pull lines held together with bolted steel plates. Many powers of this type were once used in the oil fields of northern Pennsylvania. The power proper was serviceable, but the use of wooden pull lines between the primary and secondary pull wheels was a constant source of trouble, as the lines often parted at the strapped couplings, especially during long dry periods in the summer. In addition, there was considerable lost motion between the pull wheels because of the difficulty of keeping the wooden pull lines in proper tension. Motion is lost also because of the working loose of the wooden keys in the power proper and in the primary and secondary pull wheels. For this kind of service it is very difficult to make timber braces rigid even when well seated, bolted, and keyed.

"A modern type of push-and-pull power, using steel-rod pull lines and having well built and properly erected pull wheels, with the same general arrangement as used in this old type, can be used satisfactorily, especially for a property about three locations wide and seven locations long with a total of 21 wells to be pumped from one power.

"The modern push-and-pull power of iron is driven by an engine or motor through a belt to a pulley on a countershaft to which is attached a pinion meshing with a large gear wheel mounted on a shaft having two crank arms. A

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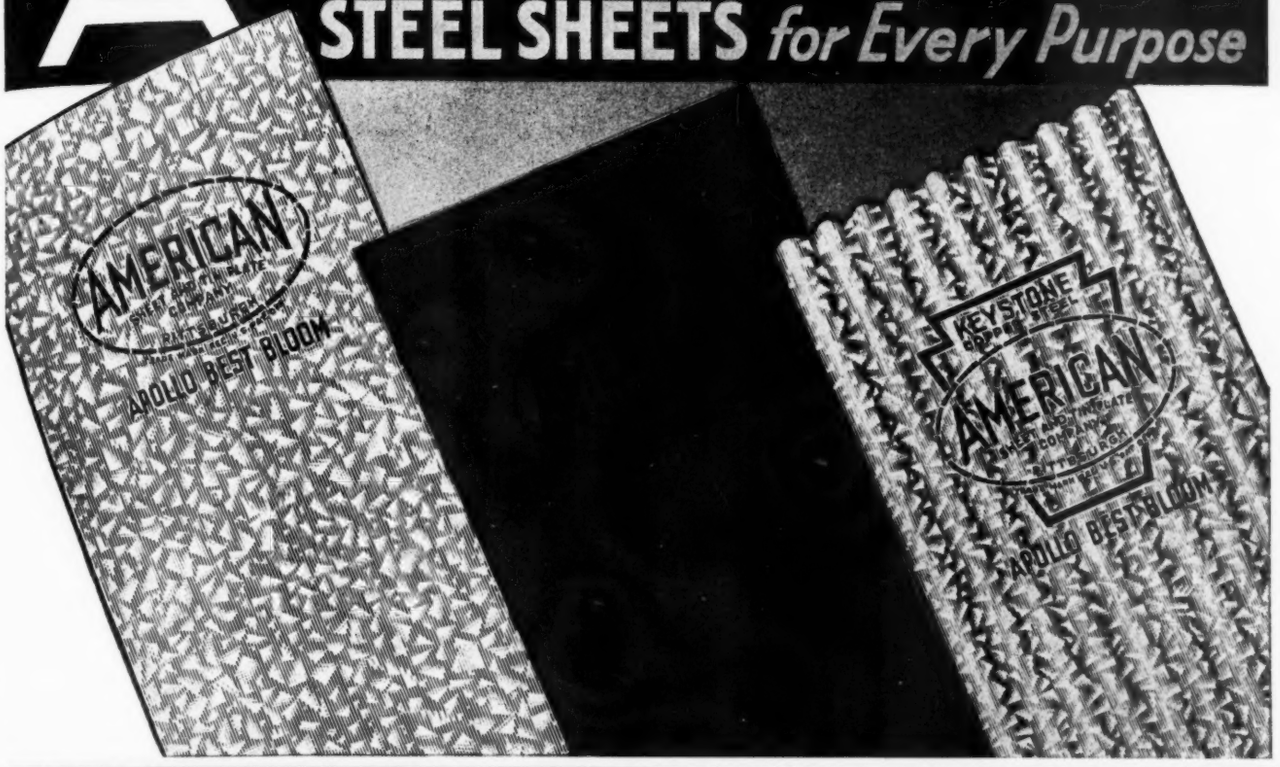

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pitman connects each crank arm to a horizontal iron disk mounted on a vertical shaft and anchored to a concrete foundation. The revolution of the pulley imparts a reciprocating motion to the disks, which move in a horizontal plane, and impart reciprocating motion to the shackle lines. When the number of wells to be pumped is small often only one disk is used and the second pitman and crank arm are not needed. * * *

"A single-disk power of this type is generally run by a 25-hp. engine or motor and is designed to handle from twelve to fifteen 1600-ft. wells, or eight to ten 2500-ft. wells, or a proportionate number of deeper wells. A double-disk power is generally run by a 35-hp. engine or motor and when properly balanced will handle nearly twice the load of the single-disk power.

"Efficient service from this type of power requires good foundations and proper alignment, a balanced load, frequent lubrication, proper condition of babbitt in boxes, and tight nuts, bolts, and keys. The pulley on the counter-shaft will make 16 to 20 revolutions a minute, which imparts the same number of strokes to the shackle lines."

BANDWHEEL POWERS

In bandwheel powers, the motion is imparted to the shackle lines through eccentrics mounted on a bandwheel. The bandwheel itself is a large belt-driven wooden or steel pulley 16, 18, or 20 ft. in diameter with a 14-in. or larger face.

Some recent installations, the best of their kind, have a bandwheel 24 ft. in diameter and 30-in. face.

The bandwheel in operation revolves in a horizontal position. Eccentrics are mounted on the bandwheel shaft. There are two general types of powers:

The overpull type,
The underpull type.

This classification is based on the method of mounting the eccentrics on the shaft. In the overpull type the eccentrics are mounted above the bandwheel, and in the underpull type below the bandwheel.

Holes, cored or machined in the eccentric straps, carry the shackle-line connections. As the bandwheel revolves the eccentrics impart a reciprocating motion to the shackle lines, which extend in almost all directions outside the power house like a huge spider.

The bandwheel is driven by a flat belt drive either direct from a pulley on the prime mover or from a pulley on a countershaft between the engine and bandwheel. One of the important parts of a bandwheel power transmission is the idler.

"The idler should be so placed that the upper length of belt, as it leaves the engine, travels as nearly as possible directly above the lower length. The idler frame should be parallel to the lower belt length so that as the belt stretches and the idler is tightened, a side pull tending to strain the fiber will not be developed in the belt as it leaves the engine pulley. The idler should not be too near the engine pulley, for then the friction surface of the belt on the bandwheel will be decreased, dequiring a tighter belt and the belt will be twisted in too short distance to meet the face of the idler, which will also tend to strain the fiber of the belt. The idler should not be placed too near the bandwheel, because then the belt is twisted in too short a space as it leaves the face of the idler to meet the face of the bandwheel, which likewise tends to strain the belt fiber.

"Idlers are of two general types: Those that are mounted on a frame bolted to a foundation and adjustable within the frame; and those that consist of a loose pulley on a shaft whose lower end is adjustable with reference to a floor anchor or foundation, and whose upper end is held in place by adjustable attachments to the framework of the power building. If the power is properly aligned, the former type meets all requirements, but if alignment is poor and the features of installation abnormal, the latter type frequently proves the more adaptable.

"An ingenious way of keeping constant tension on an endless belt used for driving a bandwheel power is to mount the idler pulley on a truck which is movable on a track running parallel to the belt as it leaves the engine or countershaft pulley. The idler is held at constant tension against the belt by means of a steel cable attached to the front end of the truck. This cable passes below the bandwheel to a point outside of the power building, where it passes under a pulley fastened near the ground, and then over a pulley fastened in a frame at a point eight or ten ft. above the ground and ending in a suspended weight that maintains the necessary tension."[52]

On an average 18-ft. bandwheel power the centers between the engine or countershaft pulley and the bandwheel will be 45 ft. and between the idler and bandwheel from 17 to 20 feet.

On a modern bandwheel power to pump 18 wells from a depth of 3150 ft. the power transmission is equipped as follows:

Bandwheel,	24-ft. diameter, 30-in. face
Belt,	24-in. 6-ply
Idler,	floating type
Prime mover,	100-hp. twin-cylinder horizontal gas engine.

It is essential in laying out a central power plant efficiently that the local field conditions be surveyed. Knowledge of the well weights should be ascertained in order to have the proper information necessary to balance the power.

"In any bandwheel power installation it is seldom definitely known whether the power is in balance, when it has two eccentrics; or in the case of a single eccentric, whether the wells being operated are hooked on in such a way as to give the smoothest performance of the prime mover. Much dependence has been placed upon the 'sound of the engine,' or the amount of belt slippage in determining whether the load is in balance. The disadvantages of a power being out of balance lie in increased fuel costs, where such purchases have to be made; wear and tear on the power itself, as well as the prime-mover; and excess whips and wear on rod lines. Taken collectively, the ill-effects of an unbalanced power accumulate into financial loss.

"Theoretically, full knowledge concerning the weights of wells to be hooked-on to a bandwheel power should be known in advance of the power installation so that the power could be most ideally placed with respect to its wells to be sure of proper balancing. In a flat country, where all the wells are about the same depth, and where the pull-rod lines do not lead over hills of sharp relief or are not diverted in direction by 'swings' or other mechanical contrivances, it is easy to calculate the approximate weights of the various wells and therewith to construct a force diagram with which

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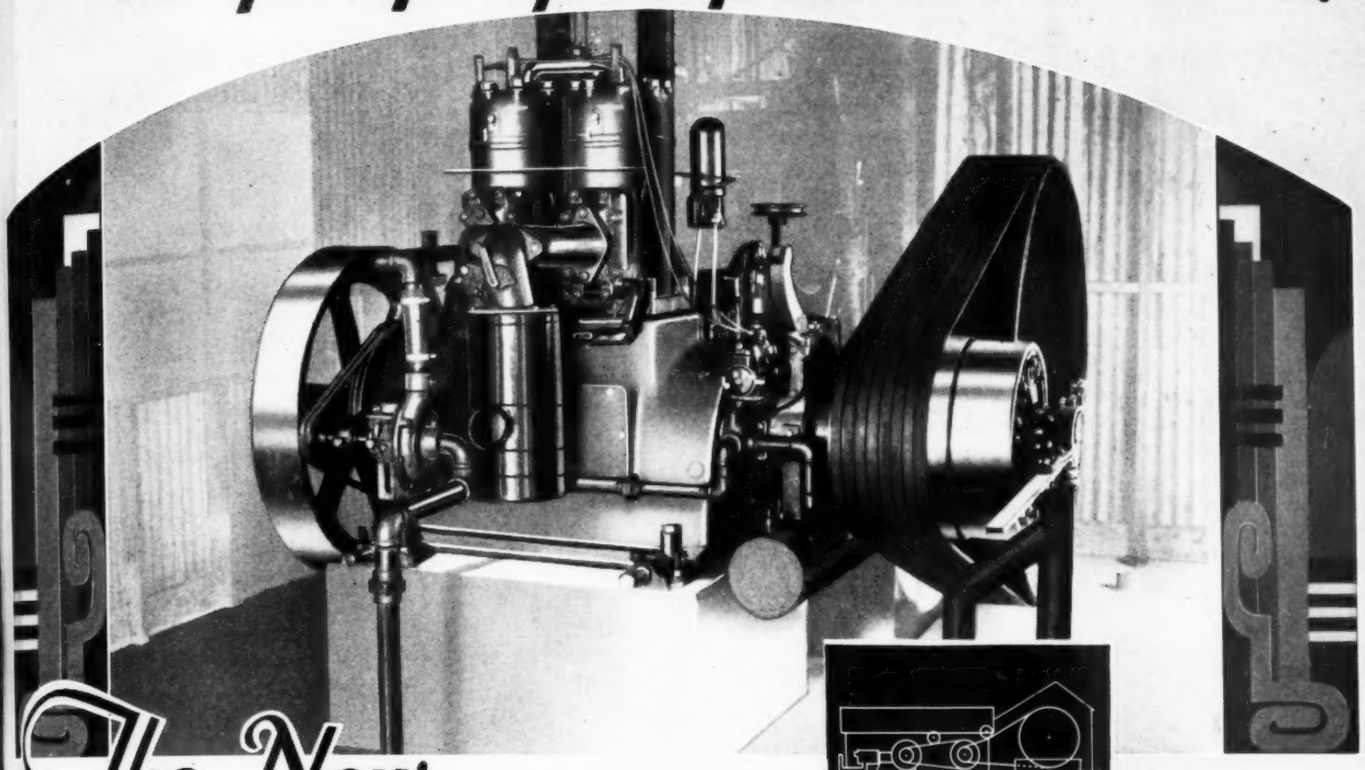

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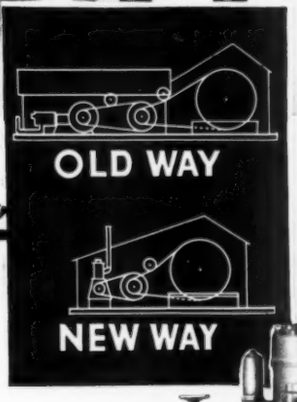

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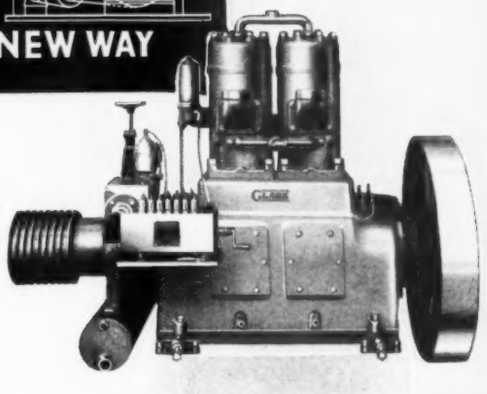

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to distribute the power properly with respect to the surrounding wells. In a country of sharp topographic relief, however, such as found in the Bradford oil field, it is a little more difficult as the wells may vary greatly in depth in a short distance, and surface features may make it necessary to use numerous swings, tie-downs, hold-ups, and others, all of which increase and vary the weight of a well and the consequent load on the bandwheel power. Under such conditions it is sometimes necessary to arrange the power in the best way with respect to its wells, and then strive for balancing by the use of a dynamometer in weighing the wells, with the idea of placing the same balanced load on one eccentric that exists on the other; or if a single eccentric power is used, to distribute the wells around the circumference of the eccentric to obtain a balanced load at any position of the eccentric. As a rule, however, after dynamometer surveys have been made on several powers enough data are available upon which well weight estimates may be based. * * *

"An analysis of these maximum and minimum weights, and a comparison between them and the actual calculated weight of fluid and rods within the well is interesting. The loads carried by sucker rods in a pumping well are composed of three distinct components, namely, the static load, the dynamic load, and the frictional load. The static load consists of the weight of the rods, the plunger, and the column of fluid lifted; the dynamic load is the load required to accelerate or put in motion the rods, plunger and fluid; and the frictional load is the resistance to motion caused by frictional effects between plunger, barrel, rods and tubing. Likewise, in speaking of the load which exists on a rod line immediately outside of the bandwheel power, the static, dynamic, and frictional loads must include the weight and frictional effects of the rod line and jack. The static load may be reduced only by changing the size or position of equipment, which is not often permissible. The dynamic and frictional loads can not be eliminated, but they may frequently be reduced by better methods of operating. The dynamic and frictional loads often are in excess of 40 to 50 per cent of the static load. * * *

"The greatest influence in lessening of load on both the up-stroke and down-stroke of a well is the well jack itself. * * * The actual weight of physical equipment and fluid within a well is generally greater than the weight shown by the dynamometer at the well. This is to be expected, and if there were no leverage action given by * * * well jack, well loads would be much greater and would correspond with the actual weights of rods and fluid.

"The well jack, however, is really a simple lever with the fulcrum (jack saddle) lying between the force which is being applied and the weight to be lifted. In a balanced lever, the product of the force in pounds and length of lever on one side of the fulcrum is equal to the product of the weight lifted and the length of lever on the other side. In a jack, the length of lever back of the saddle (fulcrum) is the remaining length of upright brace to the point where the rod line is attached. The length of lever forward of the fulcrum is the remaining length of bottom brace to the point where it meets the pitman. * * *

"The ratio of the two parts of the jack lever is an important factor to consider in all calculations for pumping wells and their loads. This factor should be determined for each well, as it can be used in all weight estimates. Pull-rod weight at the well multiplied by this factor gives the actual weight in the well; conversely, weight in well divided by the factor is equal to the dynamometer reading on the pull-rod at the well. * * *

"If one eccentric is loaded lightly compared with the other, then its wells are assisted on the up-stroke by the heavy eccentric and the fact that the unbalanced load does exist. The force brought into play by the heavier laden eccentric is a positive and assisting one. When wells on the heavily loaded eccentric come into the lifting stroke, however, there is no assisting force. Such an unbalanced condition is not desirable, because of the uneven stresses and strain in equipment and the momentary period of overloading which comes into play when the heaviest loaded eccentric is opposed to the lighter one. The same may be said of a single eccentric power where one side might be more heavily loaded than the other.

"If the eccentrics of a power are unbalanced, the motion of the power is not smooth, the efficiency of the prime mover is lessened, and the power costs increase. Under an unbalanced load there is the tendency for belt slippage to take place, which leads to high belting costs. There is also a chance for excessive wear in the eccentric rings.

"With a detailed study of the bandwheel power in endeavoring to understand the various horsepower loads, we are concerned with the maximum weights as registered by the dynamometer. The maximum load the prime mover is called upon to carry, is approximately the load of the heaviest loaded eccentric, and the advantage of balancing is shown by the following: suppose that in a two-eccentric power there is a load of 30 hp. on one eccentric and 20 hp. on the other. Because the maximum load the prime mover must handle is approximately that of the heaviest eccentric it may be seen that the expense of pulling 30 hp. a part of every revolution of the bandwheel is greater than would exist if the total 50 hp. load were distributed between the two eccentrics, or 25 hp. on each.

"Reference has been made to the proper balancing of a bandwheel power and in this service the dynamometer has its most important use. Although it was stated that the same weight should be carried on each eccentric, this is only a makeshift measure for balancing, unless precaution is taken to see that this weight is evenly distributed around the circumference of each eccentric. Even an unbalanced power may still have the same load on each eccentric."[75]

QUESTIONS

1. Name and describe briefly the different well pumping methods and systems in general use.
2. What important conditions would you say limit the use of central powers?
3. Why is the idler such a vital part of a bandwheel power transmission?
4. Why is a knowledge of the well weights essential to the proper balancing of a bandwheel power?

REFERENCES

[74] "New Oil Well Pumping Practice Introduced," by Bailey E. Price and W. L. Baker, *The Petroleum Engineer*, November, 1933.

[75] "Surface and Subsurface Equipment Loads of Bandwheel Powers," by K. B. Nowels, Pennsylvania State College Bulletin 11. (An excellent, instructive discussion of bandwheel powers).

Elements of Applied Petroleum Refining

By W. L. NELSON
Consultant*

Article XVI

PHYSICAL PROPERTIES OF FRACTIONS OF PETROLEUM OIL
(Continued)

VAPOR-PRESSURE AND CHANGE OF BOILING-POINT

VAPOR-PRESSURE is an important property because it shows what effect pressure has in lowering or raising the boiling-point of a material. Any material has a tendency to vaporize even though it is far below its boiling-point at atmospheric pressure. This tendency to vaporize is measured by the vapor-pressure. Even solids, such as ice, may exert a small vapor-pressure and ice, if exposed at temperatures below the freezing-point, will gradually vaporize so that the sharp corners become rounded.

When a material boils it is at such a temperature that its vapor-structure is equal to the pressure that is held on it. Thus, the vapor-pressure of all materials, when they are boiling at atmospheric pressure, is 760 mm. or 14.7 lb. per sq. inch. Likewise, a material that boils at 200 deg. at a pressure of 10 mm. is exerting a vapor-pressure of 10 mm. and at the same temperature, the same tendency to vaporize will be exerted, even though the pressure is above 10 mm. and the material is not boiling. In other words, the vapor-pressure of the material is 10 mm. at 200 degrees. This affords a convenient laboratory method of measuring the vapor-pressure.

In dealing with mixtures, such as petroleum oils, the vapor-pressure is not such a simple property. When part of a mixture is vaporized, the composition of the residue changes, the boiling-point increases, and no more vaporization will take place unless the temperature is increased. As an example, the Reid vapor-pressure of light petroleum oils measured by allowing a measured sample of oil to vaporize into a chamber that has a pressure gauge attached thereto. The chamber or bomb is brought to 100 deg. fahr. and the gauge shows the vapor-pressure. In this test, a part of the sample vaporizes and the composition of the residue is not the same as the composition of the original sample. Hence, by this method the vapor-pressure (Reid) is not so large as the true vapor-pressure.

The vapor-pressure of the normal paraffin hydrocarbons are given in Table 16. They are not presented in the form of a chart because a very large chart is necessary in order to be useful. The same information is given in a more useful form in the nomographic chart, Fig. 37. This chart can be used to obtain the vapor-pressure by connecting the actual temperature on the right scale with the atmospheric boiling-point of the material on the center scale by means of a rule or a string. The vapor-pressure, at the actual temperature, is read from the left scale.

Example 23—Vapor-pressure of normal paraffin hydrocarbons.

What is the vapor-pressure of normal octane at 80 deg. fahr.?

The atmospheric boiling-point of normal octane is 285 deg. fahr.

The atmospheric boiling-points of the paraffin hydrocarbons are tabulated in many reference books and text books. A fairly complete tabulation is published in *The Petroleum Engineer*, February, 1931.

Connecting 80 on the right scale to 258 on the center scale shows on the left scale that the vapor-pressure is about 15 millimeters.

The result can be checked from Table 16.

From Table 16, the vapor-pressure is 0.29 lb. per sq. in., or 15 mm.

Fig. 37 was originally prepared for the conversion of boiling-points from one pressure to another and, as explained under the next heading, it can be used for this purpose.

CHANGE OF BOILING-POINT WITH PRESSURE. In laboratory work, distillations are often conducted at other pressures than atmospheric pressure in order to avoid the decomposition of high-boiling oils. The temperatures that are recorded in such distillations must be converted to the corresponding temperatures at atmospheric pressure. Fig. 37 is most widely used for this purpose but it is not entirely exact because petroleum oils do not consist of the normal paraffin hydrocarbons. Straight-run gasolines may contain as much as 70 per cent of normal paraffin hydrocarbons, but other heavier oils contain only small amounts of these hydrocarbons.

The hydrocarbons that are found in petroleum, behave

TABLE 16

Temperature deg. fahr.	Vapor-Pressure—Lb. per sq. in. Absolute* Propane	Butane	Pentane	Hexane	Heptane	Octane
20	54.1	11.3	2.6	0.5	.....	.....
40	78.3	17.5	4.25	1.1	0.3	.....
60	106.	25.9	6.8	1.9	0.5	.....
80	141.	37.	10.3	3.1	1.0	0.29
100	186.	51.9	15.3	4.9	1.7	0.5
150	348.	106.	36.7	13.5	5.2	1.9
200		193.	73.5	30.8	12.7	5.4

*Taken from chart of Natural Gasoline Mfg. Ass'n by Brown, Coats and Badger.

*Professor of Petroleum Refining, University of Tulsa.

more as shown in Table 17. The data in Table 17 give different corrections for the boiling-point from that in Fig. 37 and in general, the boiling-points of petroleum oils are decreased more by a reduction in pressure than the boiling-points of the paraffin hydrocarbons.

The use of Fig. 37, which is exact only if applied to the normal paraffin hydrocarbons, for the conversion of boiling-points of petroleum oils from one pressure to another, is necessary because no other means of making the correction (such as Table 17) has been generally accepted by the entire industry. Thus, if no mention is made concerning the method that is used in correcting the boiling-points, it is to be inferred that Fig. 37, or the vapor-pressures of the normal paraffins have been used.

Example 24—Conversion of Boiling-Range to Atmospheric Pressure.

A topped or reduced crude oil was distilled at a pressure of 10 millimeters. A tabulation of the distillation curve is given in Table 18 and also the temperatures, after correcting them in atmospheric pressure.

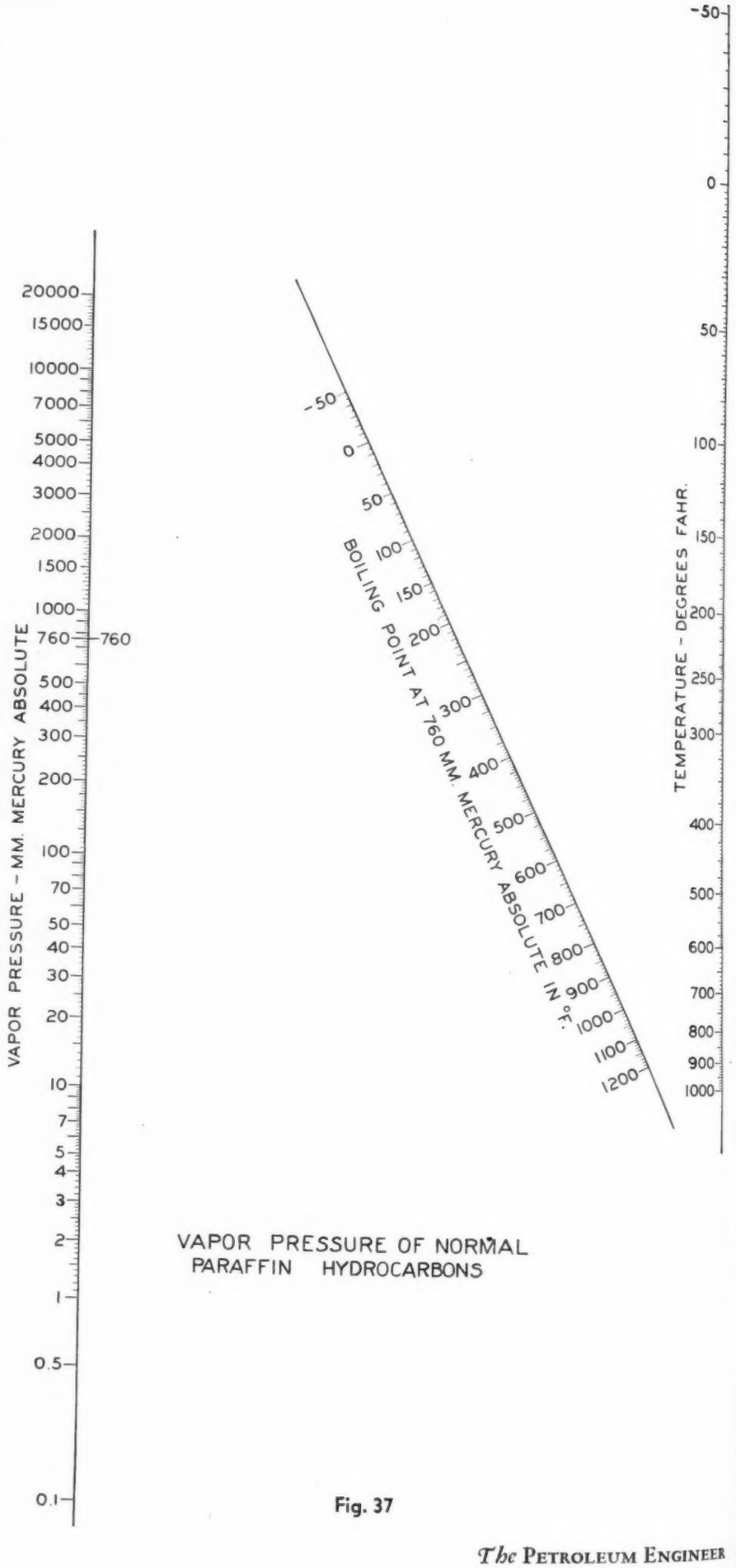
What is the distillation curve at atmospheric pressure?

One point will be computed as an example.

At 10 per cent, the boiling-point at 10 mm. pressure is 280 deg. fahr.

Using Fig. 37, connect 10 mm. on the left scale with 280 on the right scale and read 470 deg. fahr. on the center scale.

Fig. 37 can also be used in a reverse manner, that is, it may be used to determine the boiling-point of an oil at a new pressure if its boiling-point is known at atmospheric pressure. Thus, a gasoline that is completely vaporized at 280 deg. fahr., at atmospheric pressure will be vaporized at 350 deg. fahr., if the pressure is 24 lb. per sq. in. gauge (2000 mm.). This was obtained by connecting 2000 on the left scale with 280 on the center scale.



VAPOR PRESSURE OF NORMAL PARAFFIN HYDROCARBONS

Fig. 37

TABLE 17

Reduction of Boiling-Point Deg. Fahr., for Oils that Boil at the Following Atmospheric Boiling-Points

Pressure	300	400	500	600	700	800	900
760	0	0	0	0	0	0	0
500	25	29	32	....	....	....	....
200	74	82	90	96	101	107	....
100	106	117	130	137	143	153	161
50	137	151	167	179	186	196	208
20	....	190	215	227	238	254	270
10	....	....	252	267	280	298	316
5	....	....	....	305	323	342	364

COMPRESSION OF HYDROCARBON VAPORS. In refinery operation and design, question often arises about the decrease in temperature that occurs during expansion of vapors. In the case of air, steam, ammonia, etc., the decrease in temperature is great but for petroleum vapors except natural gas, the decrease in temperature is almost negligible.

The change in temperature during the expansion is governed by the following equation:

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}}$$

in which:

T_1 and P_1 are the absolute temperature and pressure at the initial conditions.

T_2 and P_2 are the final absolute temperature and pressure.

The value of the exponent k, is equal to the specific heat at constant pressure divided by the specific heat at constant volume. Table 19 gives values of k that were accumulated from the current literature.

TABLE 18

Per Cent Distilled	Boiling-Range of Topped Crude Oil at 10 mm.	at 760 mm. (Fig. 37)	at 760 mm. (Table 17)
0	176	395	411
5	235	470	485
10	280	525	535
20	351	610	619
30	411	685	689
40	468	748	751
50	530	815	830
60	601	890	915

The drop in temperature by the expansion of air and of hexane at 200 deg. fahr., to atmospheric pressure, is indicated in Table 20.

The nearer the exponent k approaches 1, the less the drop in temperature. For the high-boiling vapors, such as gasoline, kerosene, etc., it appears that the exponent k is nearly 1, and very little refrigeration occurs.

In compressors, the reverse heating effect occurs; that is, the gas is heated by compression. Natural gas compressors "run cool" as compared with air or ammonia compressors. The magnitude of the k for the two materials, also explains this effect.

Example 25—Expansion of Hexane.

Hexane gas at a pressure of 147 lb. per sq. in. absolute is to be expanded to atmospheric pressure. The gas is at 200 deg. fahr.

What is the temperature after expansion?

TABLE 19

Gas	Temperature deg. fahr.	Pressure Atmospheres	Sp. Ht. at Constant Pressure / Sp. Ht. at Constant Volume
Air	....	1	1.4
Methane . .	32	1	1.307
Ethane . . .	59	1	1.22
Propane . .	61	0.5	1.13
Pentane . .	187	1	1.08
Hexane . .	176	1	1.08
Benzene . .	194	1	1.1
Gasoline . .	300	....	nearly 1.0

$$\frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)^{\frac{k-1}{k}}$$

The value of k is about 1.08

$$\frac{k-1}{k} = \frac{0.08}{1.08} = 0.074$$

$$\frac{P_1}{P_2} = \frac{147}{14.7} = 10$$

$$10^{0.074} = 1.186$$

$$T_2 = \frac{T_1}{1.186}$$

$$= \frac{460 + 200}{1.186}$$

$$= 556 \text{ deg. fahr. absolute}$$

Exhaust temperature = 556 — 460 = 96 deg. fahrenheit.

TABLE 20

Initial Pressure	Final Pressure	Temperature of Expanded Gas in Deg. Fahr. For Air k = 1.4	For Hexane k = 1.08	For k = 1.02
147	14.7	—118	96	164
73.5	14.7	— 43	126	180
29.4	14.7	82	167	191

QUESTIONS

1. A material boils at 800 deg. fahr. at atmospheric pressure. What pressure is required to cause it to boil at 700 deg. fahr. (Fig. 37)?

   Answer: 215 mm.

2. A distillation is being conducted at a pressure of 2 mm. Thirty per cent of the material distills at 400 deg. fahr. What temperature would be required to distill 30 per cent at atmospheric pressure?

   Answer: 745 deg. fahrenheit.

3. The ratio of the specific heat at constant pressure to the specific heat at constant volume, is about 1.22 and for air, about 1.4. Which material would be the most suitable for a refrigeration machine?

4. Normal pentane boils at 98 deg. fahrenheit. What is the vapor-pressure of pentane at 60 deg. fahrenheit?

   Answer: 345 mm.

Elements of Applied Petroleum Pipe Line Transportation

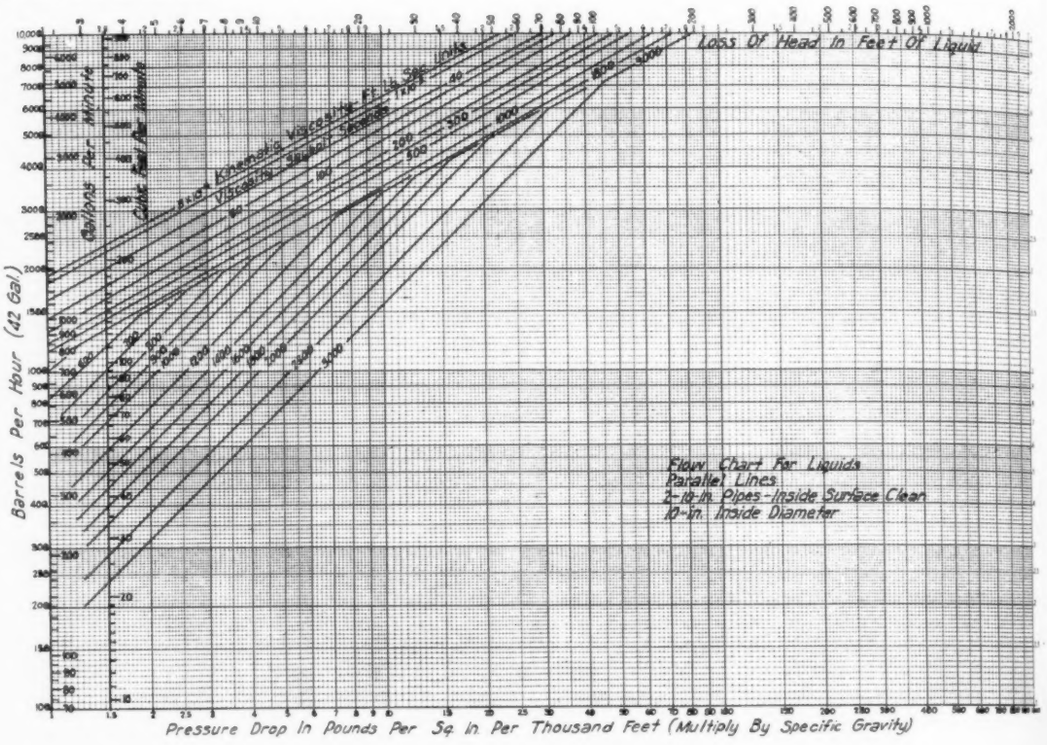
Article 7

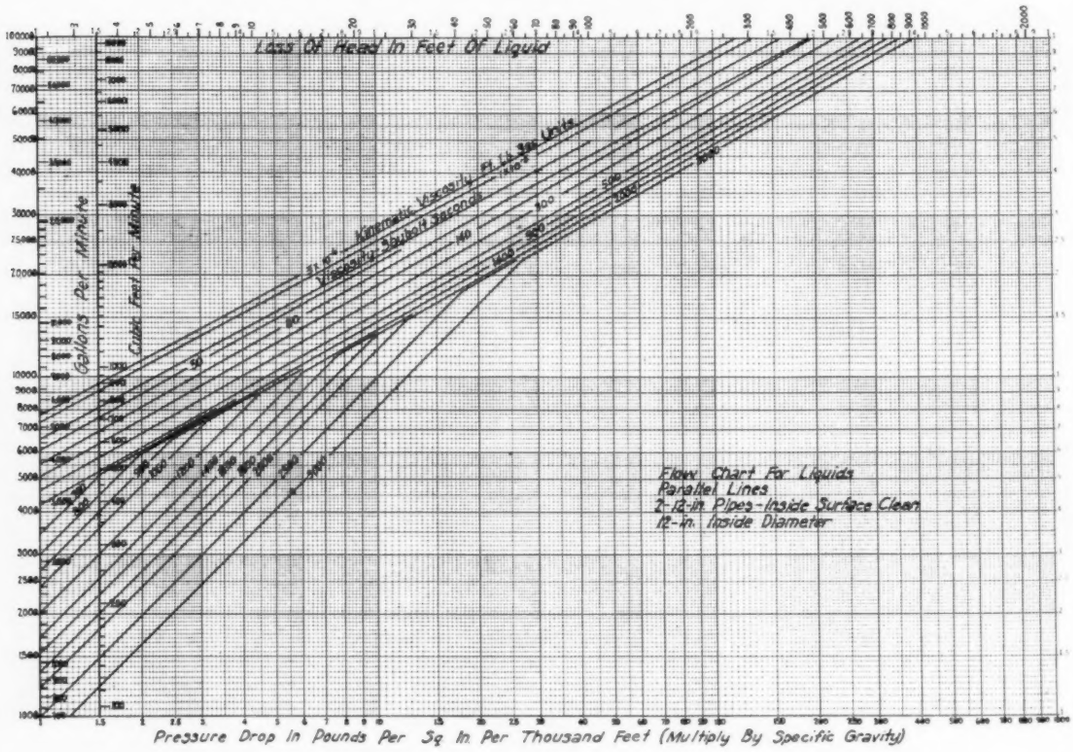
THE FLOW OF OIL IN PIPES AND PIPE LINES

By EMORY KEMLER
and L. L. THOMAS

Flow Charts

SIX more charts are given this month for the solution of flow problems in pipes and pipe lines, namely: two parallel 10-in. pipes, two parallel 12-in. pipes, 12-in. pipe, 14-in. pipe, 15-in. pipe, and 16-in. pipe.


Loss Of Head In Feet Of Liquid
Barrels Per Hour (42 Gal)
Gallons Per Minute
Cubic Feet Per Minute
Kinematic Viscosity, Ft. Lb. Sec. Units
Viscosity, Saybolt Seconds
Flow Chart For Liquids
Parallel Lines
2-10-in. Pipes-Inside Surface Clean
10-in. Inside Diameter
Pressure Drop In Pounds Per Sq. In. Per Thousand Feet (Multiply By Specific Gravity)


Loss Of Head In Feet Of Liquid
Gallons Per Minute
Cubic Feet Per Minute
Kinematic Viscosity, Ft. Lb. Sec. Units
Viscosity, Saybolt Seconds
Flow Chart For Liquids
Parallel Lines
2-12-in. Pipes-Inside Surface Clean
12-in. Inside Diameter
Pressure Drop In Pounds Per Sq. In. Per Thousand Feet (Multiply By Specific Gravity)

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UPON completion of an oil pipe line to load tankers a half mile out to sea, the Chief Engineer of the oil company was so pleased with the aid rendered by Linde Process Service that he wrote:

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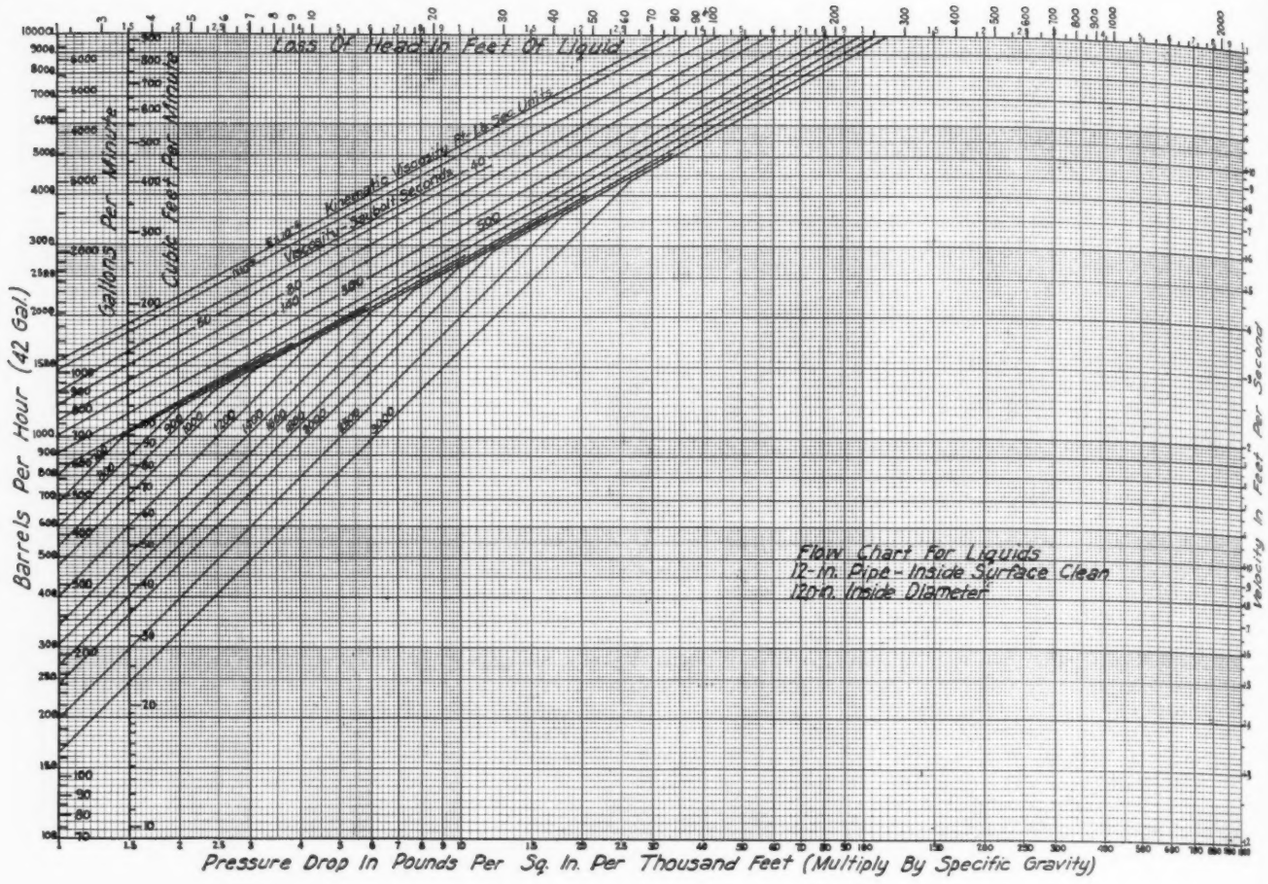
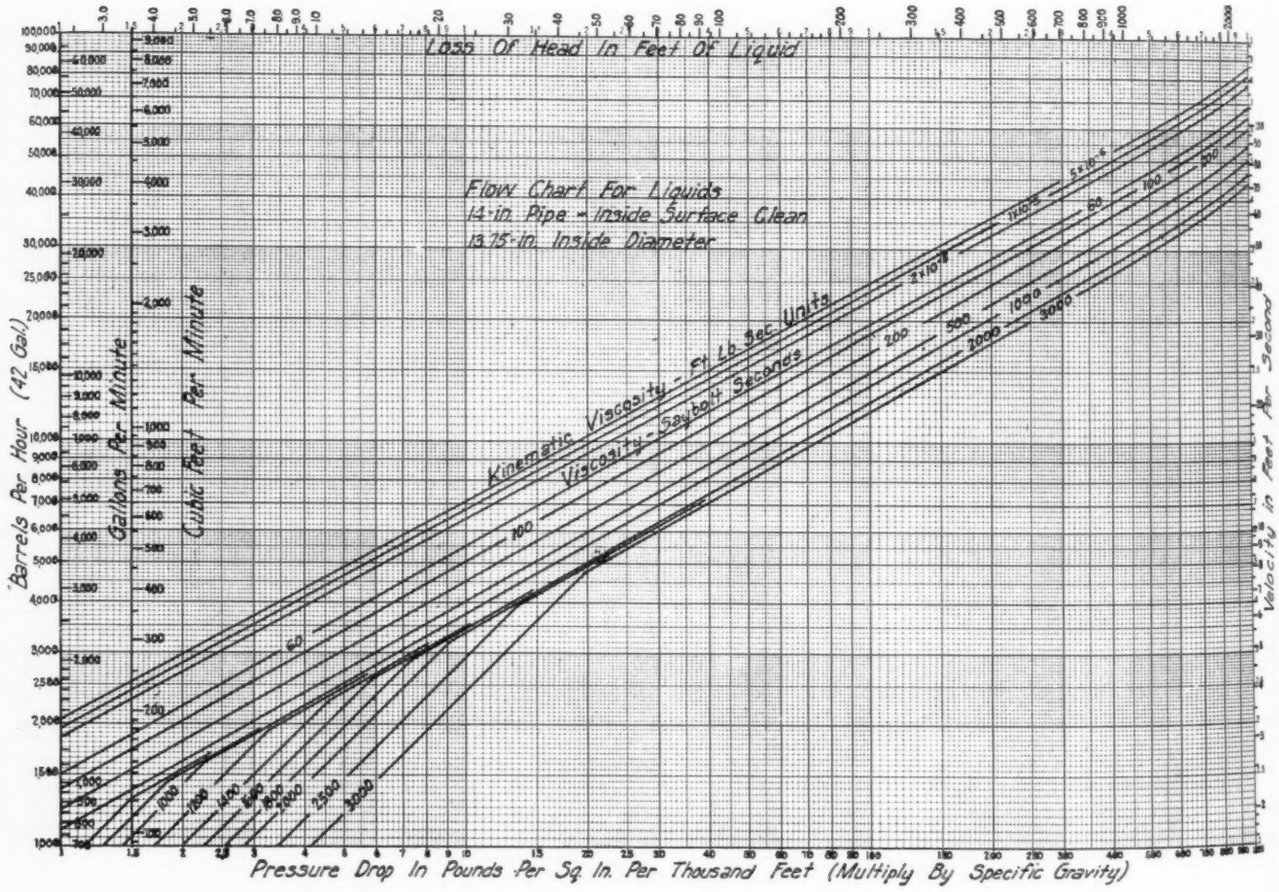
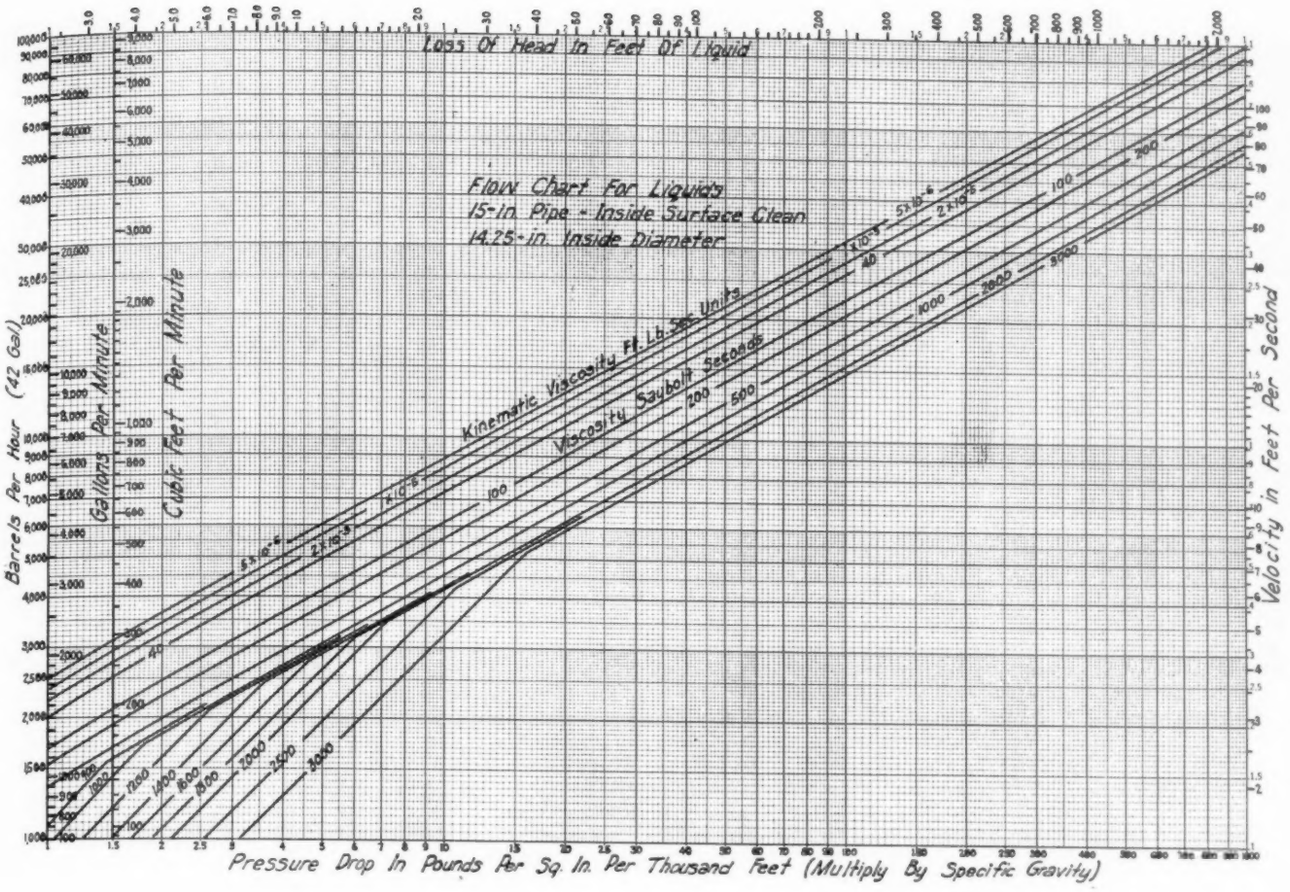
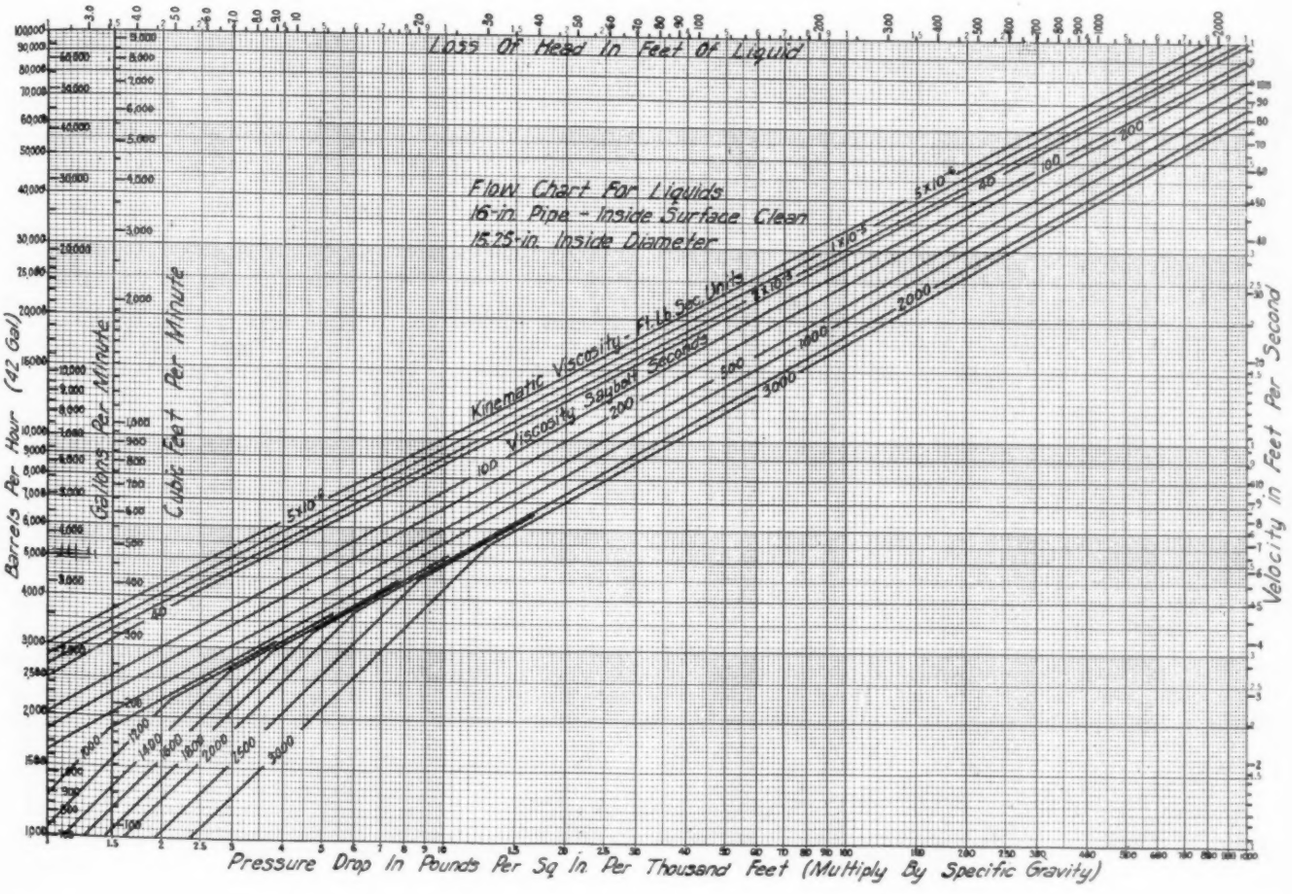

Loss Of Head In Feet Of Liquid
Barrels Per Hour (42 Gal.)
Gallons Per Minute
Cubic Feet Per Minute
Velocity In Feet Per Second
Kinematic Viscosity - Ft. Lb. Sec. Units
Viscosity - Saybolt Seconds
Flow Chart For Liquids
12-In. Pipe - Inside Surface Clean
12.0-in. Inside Diameter
Pressure Drop In Pounds Per Sq. In. Per Thousand Feet (Multiply By Specific Gravity)


Loss Of Head In Feet Of Liquid
Barrels Per Hour (42 Gal.)
Gallons Per Minute
Cubic Feet Per Minute
Velocity In Feet Per Second
Kinematic Viscosity - Ft. Lb. Sec. Units
Viscosity - Saybolt Seconds
Flow Chart For Liquids
14-in. Pipe - Inside Surface Clean
13.75-in. Inside Diameter
Pressure Drop In Pounds Per Sq. In. Per Thousand Feet (Multiply By Specific Gravity)


Loss Of Head In Feet Of Liquid
Flow Chart For Liquids
15-in. Pipe - Inside Surface Clean
14.25-in. Inside Diameter
Kinematic Viscosity - Ft. Lb. Sec. Units
Viscosity Saybolt Seconds
Barrels Per Hour (42 Gal)
Gallons Per Minute
Cubic Feet Per Minute
Velocity in Feet Per Second
Pressure Drop In Pounds Per Sq. In. Per Thousand Feet (Multiply By Specific Gravity)


Loss Of Head In Feet Of Liquid
Flow Chart For Liquids
16-in. Pipe - Inside Surface Clean
15.25-in. Inside Diameter
Kinematic Viscosity - Ft. Lb. Sec. Units
Viscosity Saybolt Seconds
Barrels Per Hour (42 Gal)
Gallons Per Minute
Cubic Feet Per Minute
Velocity in Feet Per Second
Pressure Drop In Pounds Per Sq. In. Per Thousand Feet (Multiply By Specific Gravity)

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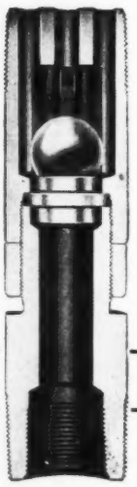

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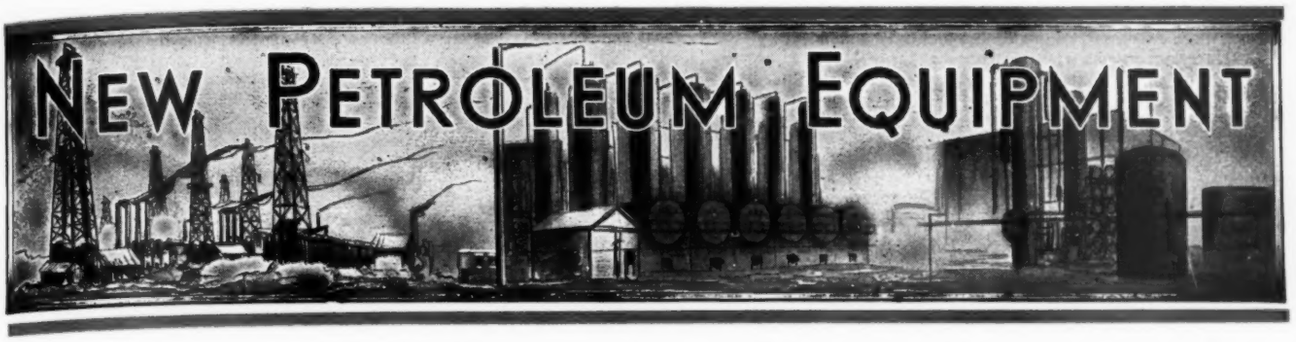
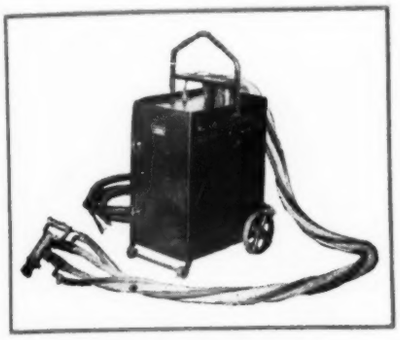


General Electric Stud Welder

A NEW portable stud welder, consisting of a welding transformer and control mounted in a portable steel cabinet, primary and secondary cable, and a stud-welding gun, has been made available by the General Electric Company, Schenectady, New York. The stud welder is an equipment for fusing the end of a stud into a metal surface—applications include welding studs to steel surfaces



for hanging piping, conduits, signs, instruments, hooks, and insulating materials.

A stud is placed in the welding gun, pressed against the surface to which it is to be welded, and one automatically timed impulse of power completes the weld.

One side of the portable steel cabinet is equipped with split steel doors that give access to the control panel. Opening the upper door automatically removes power from the panel; adjustment of current and time for different sizes of studs are made with this upper door open. The lower door is used for servicing and normally can be kept locked.

The transformer is mounted in the cabinet behind the control panel and is connected to the power supply through a 20 ft. double-conductor drag cable. The secondary of the transformer supplies heavy current at low voltage to the welding gun through hollow, forced-air-cooled flexible cables. The cooling air is admitted at both ends of each cable and is allowed to bleed out over its entire length. The secondary windings of the transformer are also forced-air-cooled, permitting the use of the minimum of material for a given capacity; in this manner obtaining as high a degree of portability as possible. The weight of the complete unit, less the cables, is approximately 500 pounds.

The welding gun is a tool for holding the stud against the work under spring pressure, and for properly directing the welding current. The gun is light in weight—most parts being of aluminum—and will accommodate studs of from ⅛ in. to $\frac{5}{16}$ in. in diameter and from ½ in. to 2½ in. long. A control switch in the spade-type handle of the gun controls the operation of an automatic timer located on the control panel. When the gun switch is closed, current flows for a definite period of time only, regardless of how long the switch is held closed. The timer is adjustable for periods of from 1/12 to 5/6 of a second, the exact time used depending upon the size of stud being applied. Once adjusted, the timer repeats the desired duration of current flow for each weld.

The new G-E stud welder is obtainable for single-phase power supplies of from 25 to 60 cycles—110 to 550 volts.

500 lb. Working Pressure Nordstrom Lubricated Plug Valves

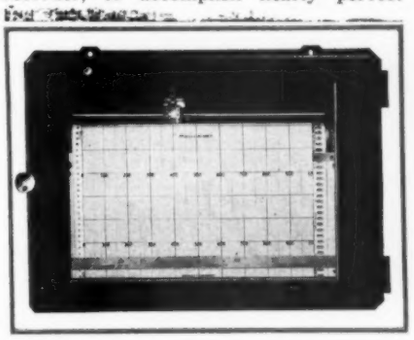
THE Merco Nordstrom Valve Company, subsidiary of the Pittsburgh Equitable Meter Company, announces a redesigned line of semi-steel, 500 lb. working pressure, Nordstrom lubricated plug valves. These valves can be furnished in sizes from ½ in. to 4 in. inclusive, wrench operated, having either flange or screw connections. In the latter case Briggs standard thread, A.P.I. line pipe thread or A.P.I. tubing thread can

be supplied. Reduced prices, made possible by the change in design, have been placed on these valves.

Bulletin V-104, giving complete information regarding this line can be obtained by addressing the Merco Nordstrom Valve Company at 400 North Lexington Avenue, Pittsburgh, Pennsylvania.

Non-Hunting, Non-Drifting Proportional Controller-Recorder Photoelectrically Balanced

THE new recording Potentiometer (or Wheatstone Bridge), manufactured by C. J. Tagliabue Manufacturing Company, Brooklyn, New York, is designed to take care of severe cases of apparatus lag, which make control without hunting difficult, and is said to attain nearly the ultimate in the successful elimination of hunting. The additions to the single-point recorder, to accomplish nearly perfect



control, are remarkably simple. They are: a control-setting slidewire, a cam-operated thermocouple switch and a cam-operated control switch. As applied to a motor-driven valve a single reversible motor is used.

The controlling action of the instrument is easily explained. While the thermocouple is connected to the recording slide-wire the contact-carriage follows the true temperature and records it. If the temperature increases or decreases the control motor decreases or increases the heat supply in proportion to the change. This connection is maintained approximately 95 per cent of the time, effectively counteracting drift. At intervals the potential of the control setting is substituted for the thermocouple, and the contact-carriage is brought to the correct or normal point (if it has been thrown off by a sudden change in heat supply or demand). During this brief interval the control motor is disconnected. Then the thermocouple and control motor are reconnected, the contact-carriage returns to the true temperature and the control motor corrects the heat supply in proportion to the measured departure from "normal."

Suppose for example, that there is a sudden temporary increase in heat demand, the severest test of such a controller where considerable lag is present in the apparatus. As soon as the tempera-

(*Continued on page 78*)

(*Continued from page 77*)

ture starts to fall the heat supply starts to increase, and this continues until the temperature stops decreasing, and starts to rise. Now even though the temperature is low, the heat supply is decreased with the rising temperature. Superposed on this action are periodic tests to find whether the temperature is below the control point, and a proportional correction is supplied, increasing the heat supply, then the reduction in heat supply immediately begins again while the temperature is rising. Presently the temperature nears the control point on the low side, when the corrections made to counteract the rising temperature begin to overtake those made for a low temperature, and the heat supply approximates the correct value at the same time that the temperature reaches the control point. It follows that overheating is eliminated or made as small as one pleases while a rapid return from abnormal disturbances is accomplished. In other words, the apparatus considered as a thermal oscillator can be effectively damped.

It is readily apparent that an outstanding feature of the instrument is the absence of a follow-up mechanism, or any mechanical device for limiting the rate of return to normal. Also, the response to initial departures is very sensitive.

The recorder-controller is available for either electric or air operated valves or electrically-heated apparatus but is not available in multiple-point or non-recording control.

The Potentiometric controller with photoelectric action is an indicating controller in which a reflected narrow beam of light from a mirror-galvanometer plays on the edge of a shield in front of a photocell. A slight deflection of the beam from the edge gives instant response in turning on or off the power to the controlled apparatus. This is contrasted with the limitation of a pointer galvanometer with which a mechanism serves to detect deflections at relatively long intervals. For industrial purposes there is in this new controller an overabundance of available sensitivity, which has to be kept within reasonable bounds, and for laboratory purposes, it is nearly unlimited, such that the instrument must be supported free from vibrations to develop its full sensitivity as required in control of a bath to a small fraction of a degree. Freedom from vibration is in truth the primary factor in laboratory applications, while in general industrial use where vibration improves control the limiting factor is the acceptable wear on relays which can be operated as fast as a furnace can be heated or cooled a fraction of a degree. This means that high temperature heat-treating furnaces can be controlled as close as desired to the selected temperature. In the absence of a muffle, on and off control (all on and all off) may wear out relays too rapidly unless the sensitivity of the instrument is adjusted to a desirable value such that a one or two degree swing is permitted. In the presence of lag as in a muffle furnace, two or three position control give excellent results.

This controller is a very simple instrument because the only moving parts are the galvanometer and relay. A special circuit is used, so that the relay can be adjusted to close and open for as small a galvanometer deflection as the installation warrants. The photocell is, of course, not a calibrated element of the measuring circuit, and it and the amplifying tube will last years unless broken. The lamp is designed for 10,000 hours (about 14 months) at normal voltage.

For the purpose of indicating temperature (or emf) a portion of the light beam from the galvanometer is intercepted by a 45 deg. mirror and reflected upon a window in the door over the circular scale of the instrument. The action of the controller is readily visible at a great distance as a brilliant line of light moves to and fro in the middle of the window. The scale and slide-wire of the potentiometer are 15-in. long, ample length for most purposes, especially because very open scales with suppressed zero can be supplied. As an electrical measuring instrument the accuracy is 0.1 degree.

The models available are for "on and off" two and three position controls, in single or double range for thermocouples and resistance thermometers. The latter are offered especially for laboratory purposes where highly sensitive control is desired, and for industrial low-temperature control. Power relays with open or mercury contacts can be furnished mounted within the case and in some models the photocell relay is inclosed in an explosion-proof housing

The indicating Potentiometer or Wheatstone Bridge is a simple indicator for measuring temperatures with thermocouples or resistance thermometers. It is calibrated to 0.1 degree of full scale, has a very accurately reproduced circular scale of 15-in. long, and is most easily balanced and read with the bright line of light showing in the window just over the scale. The instrument is designed for use in both plant and laboratory, being rugged enough to withstand the severest plant usage, and accurate enough for a wide variety of laboratory measurements. Readings can be taken quickly because the galvanometer has a short period and ample sensitivity—the light beam is equivalent to a pointer 10-in. long. It can be balanced and read in the laboratory mounted on a table, by an observer either seated or standing and in the factory on a panel, it can be read in very poorly lighted places, in fact in the dark.

The indicator is available in all the standard arrangements such as single or double range suppressed zero, etc. The standard model requires connection to a lamp socket (110 a.c.) but a portable model with a battery operated lamp will be procurable as soon as the specially designed lamps are obtained.

New Method of Swinging Casing in Hole Before Cementing

OIL Center Tool Company, Houston, Texas, has introduced to the field a new method of swinging casing in the hole before cementing, through use of a combination of the company's Type "L" bradenhead and Type "D" blowout preventer. Casing is run through the blowout preventer and swung in the bradenhead.

This method offers the operator blowout protection during the entire time the casing is being run. Fig. 1 shows a view of the blowout preventer closed around the casing and sealed off, and Fig. 2 shows a view of the preventer and the bradenhead after casing has been run and suspended on the packing unit in the bradenhead, ready for cementing. Auxiliary packing is provided for use between inside of bradenhead and outside of collar. In connection with this packing a packing gland and gland lock nut is furnished.

Swinging of the casing before cementing eliminates the time and trouble of backing the last joint of casing out and cutting a casing nipple the correct length.

With this method there is no necessity of hanging the pipe string on elevators or rotary slips while cement is hardening.

The packing element of Type "L" bradenhead is rubber or asbestos.

The safety of this method of swinging casing before cementing has been proved in the field, it is stated, with the safety element being particularly evident where there may be upper gas sands that carry any appreciable amount of pressure.

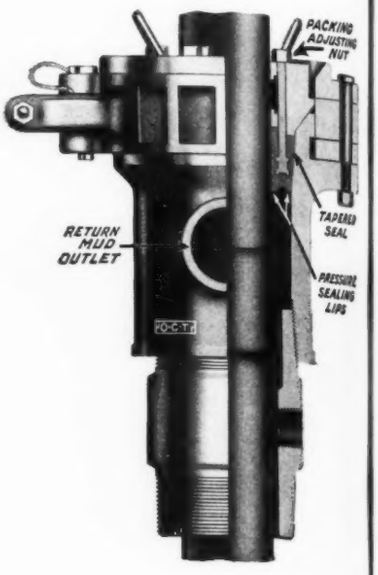


FIG. 1

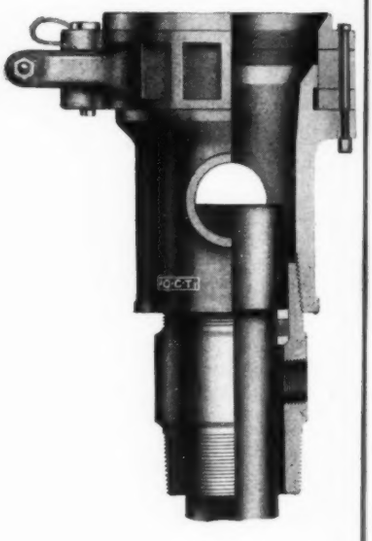
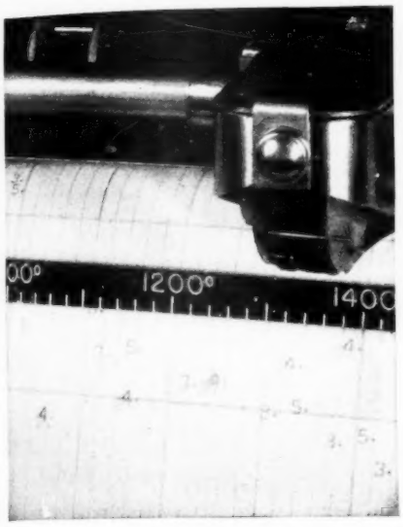


FIG. 2

Introduce "Numerals in Colors" for Multiple-Point Recording

READING of multiple-point instrument records is greatly simplified by a new system of "numerals in colors" introduced by Leeds & Northrup Company, Philadelphia. This marking system can be specified on Micromax strip-chart recorders for two, three, four or six points. With each of the thermocouples, resistance thermometer bulbs or other primary elements identified on the chart by a numeral, and each numeral distinguished from the others by being printed in a contrasting color, reading



of records is made easy, errors are avoided and time is saved, the manufacturers state. Colors used for printing the numerals are black, green, red, violet, yellow, and blue.

The print-wheel on these Micromax Multiple-Point Recorders has a separate inking pad for each point to be recorded.

A circular giving further details and showing a reproduction of an actual chart in all six colors will be sent on request. Address the above company and ask for Circular No. 314-I.

Splash-Proof and Weather-Proof Drives

THE Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania, announces a new

splash-proof, drip-proof and weather-proof motor for use indoors or outdoors, or for any applications where drippings or splashing liquids are encountered. This motor is entirely new in that it is not an adaptation of an open machine with enclosures applied around the frame, but has been built with the motor frame and end brackets of solid castings for this special class of service. The case iron, being of thick cross section and inherently resistant to rust and corrosion, makes this motor highly resistant to the sour gases encountered around a refinery or the chemicals that may be encountered in a chemical plant, paper mills, etc. Even the conduit box is made of cast iron so that there are no exposed sheet steel parts to be attacked by corrosion.

A baffle plate cast integral with the inner side of the motor bracket prevents splashing liquids from reaching the motor windings. In fact, this motor is so well protected, that it may be used outdoors the year round without additional protection.

These motors are offered with either ball or sealed sleeve bearings, enabling the purchaser to take advantage of the lower price at which the sleeve bearing motor is quoted as compared with the ball bearing motor and at the same time gain the advantages of the sealed sleeve bearing with its long life and low maintenance features, the manufacturers state.

The splash-proof motors are rated 50 degrees continuous and are offered in both the squirrel cage and wound rotor types.

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Wherever you may look throughout the oil and gas fields you will find COOK'S GRAPHITIC IRON Piston Rings at work keeping down operating and maintenance costs. More and more COOK'S Rings are being used because operators of internal combustion engines are demanding the economies in operation and maintenance that result from the superior wearing properties of COOK'S GRAPHITIC IRON. Among these economies are: reduced cylinder wear—added years of engine life and the savings that attend fewer shut-downs for repairs.

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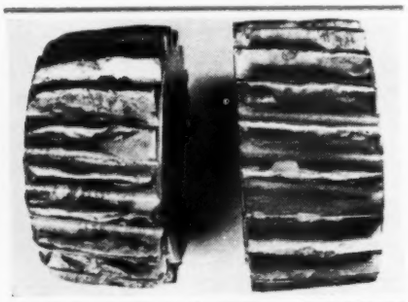
Hard Facing Rod for Bits and Reamers

A NEW, moderately priced, and what is claimed to be a very satisfactory hard facing rod for bits and reamers, is announced by Armite Laboratories of Los Angeles, California. According to the manufacturers, this new rod for acetylene use is comparable in hardness



No. 1 No. 2

to diamond inserts. It has equal, or greater, covering power, and forms a superhard tough armor, they state.

The rod forms a perfect weld to the parent metal, is completely melted by the acetylene flame, and, therefore, according to Armite Laboratories, does not come under existing patents that might otherwise prohibit its use.

The accompanying illustration is that of two cutters from the same rock bit from a run in hard rock, No. 1 faced with tube stock and No. 2 with the new Armite "K" rod. The Armite faced cutter is seen to have maintained a greater diameter and sharper edges without chipping.

In facing drag bits the saw-tooth effect is easily accomplished by first cutting shallow grooves, then filling with this new metal.

For further information address Armite Laboratories, 1900 East 65th Street, Los Angeles, California.

Brodie Company Adds to Line of Meters

THE large positive displacement petroleum meter shown in the accompanying illustration is the latest addition to the well-known line of Brodie Meters. It is called the X-500 and has a gravity flow capacity of 600 gal. per minute.

This make of meter is widely used in the petroleum industry for measuring petroleum products at bulk plants, loading-racks, from tank-trucks, and for barrel filling.

Every gallon of liquid is volumetrically displaced by two pistons moving in calibrated cylinders. There is no by-pass. Operation is said to be so sensitive that pipe-line flow is not slowed up. The refinery uses of the X-500 include metering to and from tank-cars, ships, on gathering lines, or wherever large liquid volumes move through pipe lines.

Complete information, including dimensions and flow sheets, can be obtained from the Ralph N. Brodie Company, 971 61st Street, Oakland, California.

Timken Bearings Easily Removed from Split Housing Assemblies

ANY type of anti-friction bearing must be mounted on a live shaft with a press fit, particularly where the loads are heavy or the speeds are high. In general, all Timken cones supplied with a standard bore tolerance of plus .001 in. should be fitted with a normal press fit of .0005 in. per in. of shaft diameter. For cones supplied with a cone bore tolerance of plus .0005 in. and used in precision mountings, such as machine tool spindles or where the cones are mounted on hardened and ground shafts, a press fit of from .0005 in. tight to .0015 in. tight is satisfactory.

Timken bearings are all designed to take thrust load. Consequently any load applied to the cups in removing the bearing will result in radial pressure which would make it more difficult to slide the cone off the shaft. Therefore, to remove Timken bearings easily, pressure should be applied only to the cones.

Fig. 1 illustrates a typical method of mounting Timken bearings in a split housing, using the double bearing mounting as an example. The unit shown is a fixed box, as contrasted to a floating mounting.

As installed, the bearings shown are located by means of a split spacer ring fitting into a recess in the base and cap of the housing. The inner bearing cone is located by a shoulder on the shaft, and adjustment of both bearings is accomplished by means of thin metal shims between the end plate and the end of the shaft. This set-up is shown in the figure.

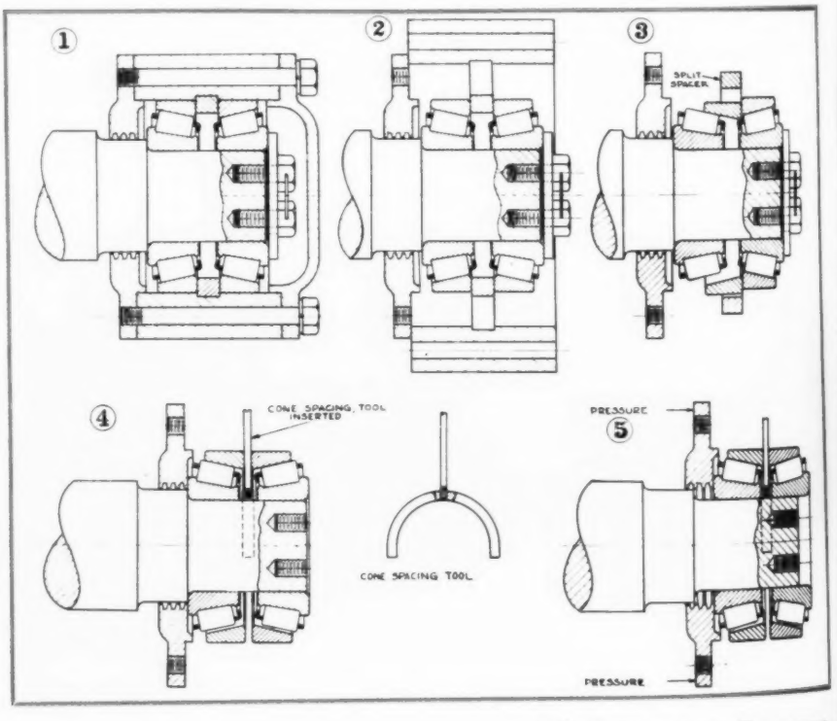
Fig. 2 illustrates the first step in removing Timken bearings from such a mounting. The through bolts are removed, which releases the cover plate and the bearing cap and base. The shaft and bearings can then be removed as a unit from the housing.

When the shaft and bearings are removed, as shown in Fig. 3, the split spacer ring separating the cups is loosened and removed. This permits the inner cup to slide down on the rolls out of the way so that pressure can be applied to the inner cone for removing the bearing from the shaft.

The next step in the disassembly is to remove the end plate and adjustment shims, as shown in Fig. 4, and to insert a cone spacing tool between the two bearings. This must be sufficiently thin to pass between the roller cages of the two bearings, fitting into position around the shaft between the cones.

Pressure can then be applied on the inner closure plate, as shown in Fig. 5. This starts the inner bearing cone and the force is transmitted to the outer bearing cone through the tool, with the result that both bearing assemblies slip off the shaft smoothly and with the application of a minimum of force on the closure plate.

When bearings are removed as outlined in these illustrations there is no possibility of harming either the bearing or the shaft. The procedure is simple, efficient, and easy, and The Timken Roller Bearing Company, Canton, Ohio, recommends it as being a satisfactory method of disassembly for their product when it is necessary to inspect them or remove them for any cause.

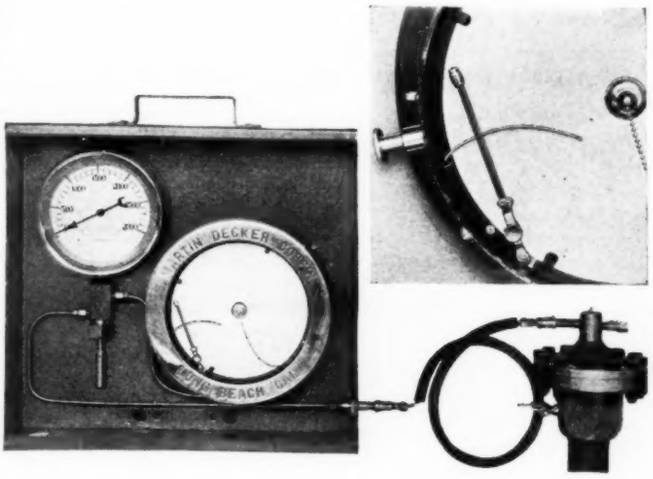


Oil Well Cement Gauge

MARTIN-DECKER Corporation, Long Beach, California, announces the perfection of an instrument for recording pressures developed during cementing operations. The recording device, of 3000-lb. capacity, contains a clock that turns the chart one revolution in four hours. In order that a legible record be obtained the chart driving mechanism turns faster than most recording devices and may be started and stopped at will by the operator, the manufacturers state. When the truck is ready to run cement the clock is wound up, a new chart placed upon the recorder and the zero line placed at the point of contact of the fountain pen. As soon as the cementing operation is started the operator merely pulls out the knob on the side of the instrument, automatically dropping the pen point onto the paper, and starting the clock. A record of the pressures encountered and the length of time required to put the cement away is then plotted. To eliminate pulsation the recording gauge has a pulsation damper attached.

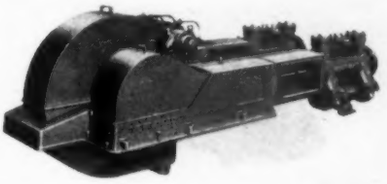
Both the indicating and recording instrument are mounted securely in a special steel box. These boxes are mounted on the back of the cab or in the most convenient place on the truck.

On the back of the recording chart is provided space for writing down valuable information, such as the number of sacks of cement, the amount of water used, the amount of chemicals, if any, the size of casing, and such other information as may be needed for future reference.



Worthington Announces Advanced Type Power Pump

WORTHINGTON Pump and Machinery Corporation, Harrison, New Jersey, announces the completion of an 18 in. stroke totally-enclosed horizontal duplex power pump for a wide range of services. This pump incorporates some unusual features and is of strictly modern design. The power end is self-contained, is supported on the foundation throughout its length, and is designed to minimize the cost of foundations. The complete pump may easily be set up without danger of misalignment and, once set, it is permanently in line.



The power end is simple, strong and ruggedly built for hard continuous duty with a minimum of attention. The frames are cast enbloc and all moving parts are totally enclosed; dust, dirt, grease, and oil tight. The crankshaft, pinion shaft

(Continued on Page 83)

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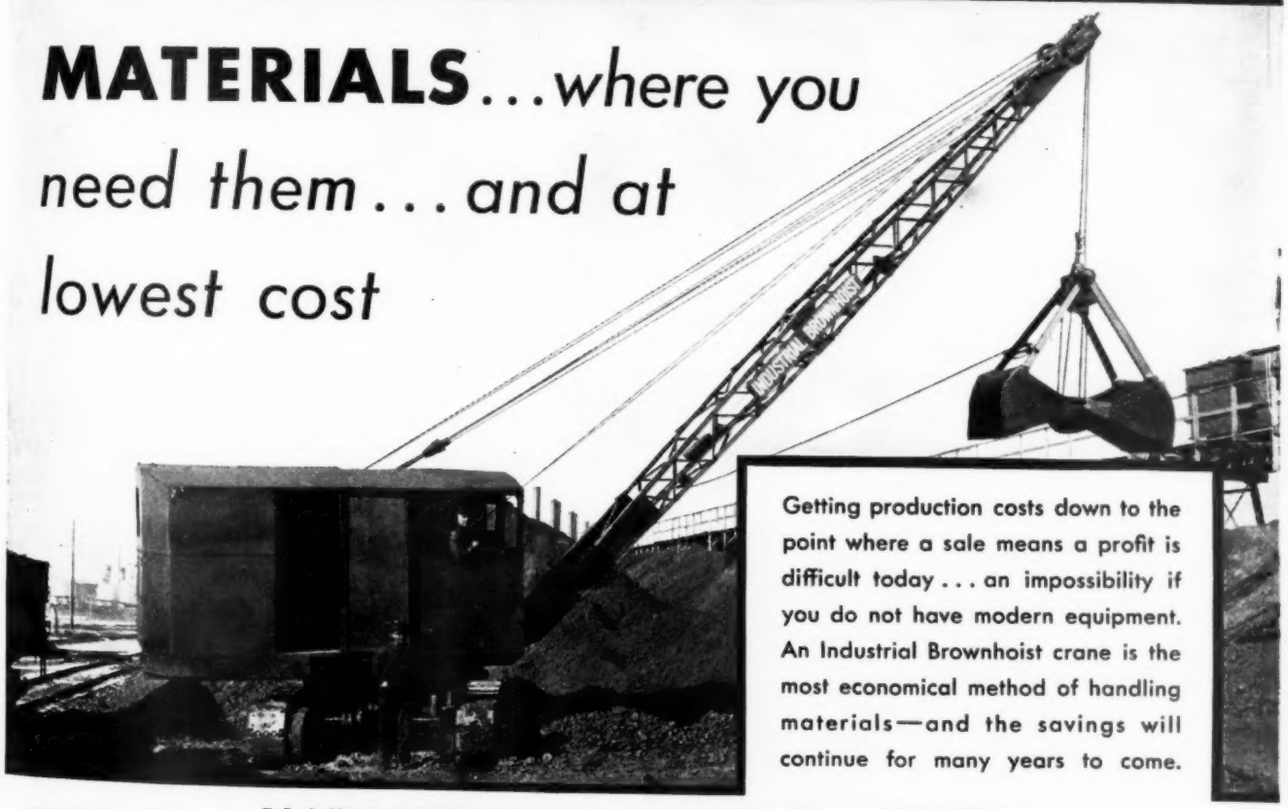

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Two Developments for Protection of Pipe Lines Against Corrosion

WAILES DOVE-HERMISTON CORPORATION, 17 Battery Place, New York City, has produced two new developments for protection of oil and gas pipe against soil corrosion, officials of the company announce.

The first is an improved grade of Bitumastic enamel. The material, known as Bitumastic 70-B Enamel, will not sag in summer temperatures and does not require any conditioning by the use of flux for low temperature conditions, it is stated. The same material is therefore used regardless of temperature conditions of exposure. It is used for all types of shielded or wrapped, machine-applied coatings, to prevent possibility of sagging or cracking from extremes of temperature after the coated pipe leaves the shop or storage yard.

The other development is a new pipe coating machine. It was developed principally to apply a hot bituminous coating to pipe, followed, as part of the same operation, by an overlying CEM-WRAP shield of ¼ in. cement mortar. Felt wrappings, either single or double, and bonded or unbonded, also can be applied easily over the enamel coating instead of the cement mortar.

In order to provide fast application, a new and very simple end feed device was invented to convey the primed joints of pipe through the machine. These joints are temporarily fastened together by couplings so that an endless string of pipe is coated and wrapped. The pipe revolves at the proper speed as it passes through the machine.

The pipe first passes over a tank of hot Bitumastic 70-B Enamel. This hot enamel is pumped to a discharge nozzle above the pipe. It then floods the entire surface of the revolving pipe and the excess flows down into the tank.

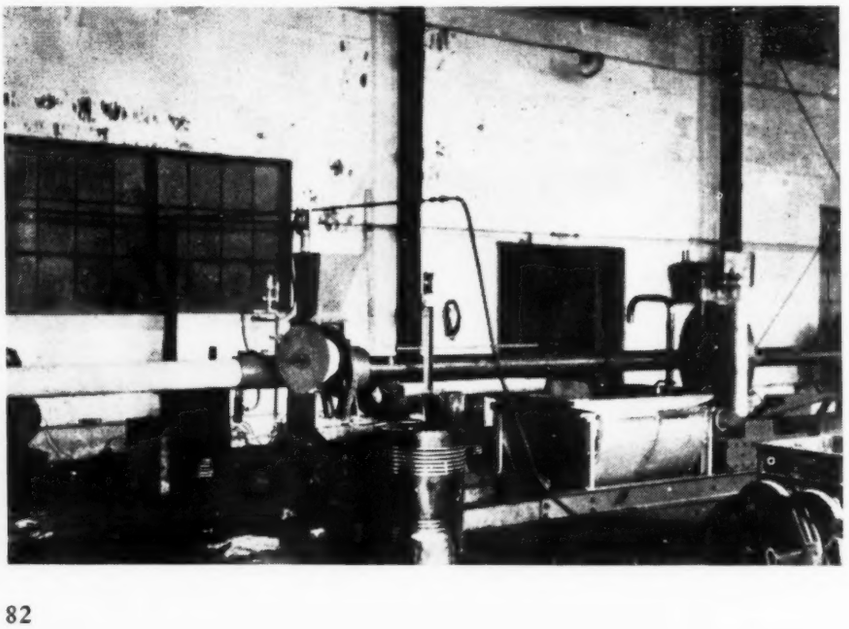
The revolving of the pipe allows the enamel, in cooling, to distribute itself in an even thickness on the pipe surface.

The enameled pipe then enters the CEM-WRAP header. In the header the cement mortar is distributed evenly around the pipe surface and spirally wrapped at the same time with a suitable grade of heavy cotton cloth applied under the proper tension. High frequency vibrators are situated at strategic places on the header. These insure a continuous flow of cement mortar and also settle the voids. The vibration transmitted to the ¼ in. thickness of cement mortar on the pipe surface, together with the use of a dry mix, is very effective and produces a shield of exceptional hardness and density.

After the coated and shielded pipe emerges from the CEM-WRAP machine, the joints are parted. Excess material is removed at each end to provide for subsequent field connections and the cloth wrapper is taped at each end. The coated pipe is ready for shipment after the cement mortar armor has cured sufficiently.

Felt wrapping, if desired, is applied by substituting for the CEM-WRAP header, suitable reel holders and other equipment. A single or double wrapper can be applied, either bonded or unbonded. Enamel can be applied over the felt followed by Kraft paper. All felt wrapping is applied under suitable tension. For the double bonded wrapper, each layer of felt is compressed immediately after it is applied so as to squeeze out all pinholes and voids.

In the field, the CEM-WRAP pipe is connected by welding or mechanical couplings. After this work is completed, the exposed steel at the joints is coated with a suitable Bitumastic material. Then cement mortar is applied over these coated joints with a trowel or light steel metal form to a thickness of at least twice that of the CEM-WRAP armor. This field application of cement mortar overlaps the machine-applied CEM-WRAP armor, and provisions for expansion can be made.



American Meter Company's Type W Case

AN important advance in appearance, utility, and convenience of orifice measurement and flow control instruments is announced by American Meter Company, 60 East 42nd Street, New York, in the development of their new Type W case shown here. The improved case is now standard for this company's entire line of recording and integrating

flow orifice meters, rate-volume controllers, liquid-level indicators, and controllers. Simple lines and velvet black finish are in keeping with the highest standards for both instrument and panel board design.

The case body and door are cast of an aluminum alloy with special attention given to the construction of door hinges and hinge pins, produced from special alloys to minimize the possibility of corrosion. A sponge rubber gasket secured in a recess of the door makes the case moisture and dust proof.

Time and labor are saved in the necessary inspection of the instrument by making the chart dial size such that the pressure spring, stuffing box and other working parts are visible when the door is open, the manufacturers point out. The new case is made highly satisfactory for flush mounting. For that type of installation a flange is cast integral with the case, the door being hinged to the flange.

For use with flow control instruments, the Type W case has the air supply gauge and the gauge indicating the pressure on the diaphragm head of the control valve, mounted on brackets secured to the inside of the case. The door is provided with two additional round windows, making these gauge indications visible at all times. The construction here also facilitates flush mounting, since all air connections are behind the panel board and are made into flanges secured to the sides or back of the case.

With special production facilities for producing this case, as well as the other parts of its instruments, American Meter Company has further insured its ability to make the prompt deliveries demanded in today's market.

Hercules Motor Adds to "JX" Series Six-Cylinder Gasoline Engines

THE Hercules Motors Corporation of Canton, Ohio, has added a larger bore model to its "JX" series of 6-cylinder gasoline engines. This, the "JXD," 4 x 4¼ in., 320 cu. in. displacement. As will be noted from the accompanying illustration this is a neat and compact design.

This engine develops 83.8 hp. at 2800 r.p.m. and 65.5 hp. at 1800 r.p.m., with maximum torque of 204 ft-lb. at 1000 r.p.m. (N.A.C.C. Rating 38.4 hp.). A 2½-in. chrome molybdenum crankshaft is supported by seven bearings of the high lead bronze precision type. The cylinder and crankcase are cast integral of molybdenum alloy iron. Cylinder head is detachable, the "L" head design being fitted with exhaust valves 1⅜ in. clear diameter —inlet valves 1½ in. clear diameter.

Lubrication is forced feed by geared pump to all connecting rod and main bearings, oil thrown off from the rods lubricating the cylinder walls. Aluminum alloy pistons are fitted with four rings all above the piston pins, an oil control ring 3/16 in. wide and three compression rings ⅛ in. wide.

A four-bearing camshaft situated on the right-hand side of the engine looking from the flywheel has all cams forged integral.

All connecting rod bearings of high bronze precision type are 2 in. in diameter, the length of rod being 8 in. from center to center. Eeither a 1¼-in. or 1½-in. carburetor can be installed and a distributor mounting is provided on the left-hand side where the centrifugal water pump also is mounted. A magneto mounting is available as optional equipment.

This "JXD" is supplied with No. 3, No. 4 or No. 5 bellhousing for three- or four-point suspension, and flywheels for any standard clutch.

Standard ⅞ in. x 18 in. spark plugs are used.

The three other sizes in this "JX" series are:

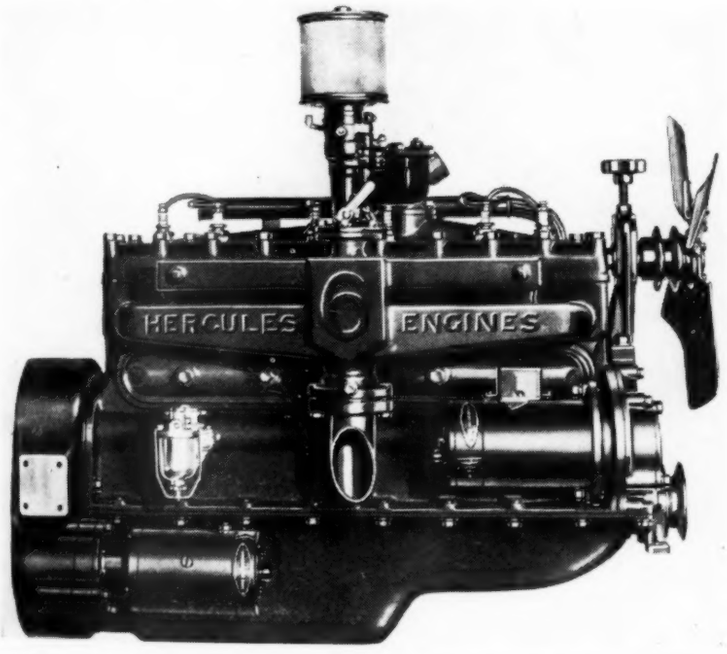
"JXA" 3⅜ in. x 4¼ in., 228 cu. in., 63 hp. at 2800 r.p.m.

"JXB" 3⅝ in. x 4¼ in., 263 cu in., 68 hp. at 2800 r.p.m.

"JXC" 3¾ in. x 4¼ in., 282 cu. in., 73 hp. at 2800 r.p.m.

All four engines in this series are identical as to installation measurements, thus facilitating the installation of the model developing the desired performance.

The four sizes in this series also are supplied as power units, either of the open or fully-enclosed type. Radiators, clutches, electrical units and all required accessories, such as reduction gears and stub shafts, are available to best meet the particular application.



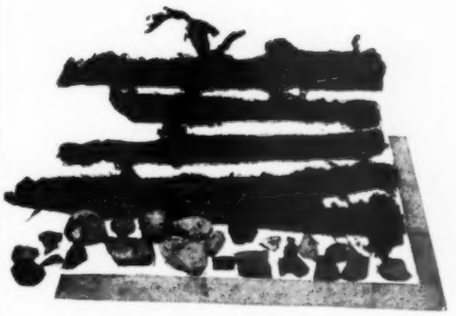
Advanced Type Power Pump

(Continued from Page 81)

and crank pin bearings are the self-contained, double-row, tapered roller anti-friction type. An oil pump, driven by a crank from the pinion shaft, supplies oil for the flood lubrication of all bearings and the pressure spray lubrication at the intermesh of the gear and pinion. The main gear and pinion are full herringbone and may be of any ratio required up to 9.66 to 1.

The totally-enclosed power end was developed primarily for refinery service, but, because the moving parts are fully protected from dust and dirt, it has a wide field of usefulness in field and pipe line service for loads up to 200 hp. The totally-enclosed power end is designed for use with either the packed piston or outside-end-packed plunger types of liquid ends for either hot or cold liquids.

The accompanying illustration shows a Worthington piston pattern power pump with a totally-enclosed power end. The liquid end is the Worthington HiVol, a true close-clearance pump known throughout the refining industry as "the pump for pumping propane, butane and other highly volatile liquids.



Seventy-five pounds of millings recovered by the Cavins in one run

IT GETS WHAT IT GOES AFTER

The CAVINS is absolutely dependable in operation. It gets what you send it after. It breaks hard packed sand bridges and cleans the pipe perforations, or screens, thoroughly. Saves time, labor, production and money. It's the modern way, the easiest way, and the best way to clean out and recover such "fish" as pins, cones, discs, slips, and ordinary junk like pieces of rubber, iron, steel and wood weighing up to 40 pounds. Write for Bulletin and further detailed information.

The CAVINS

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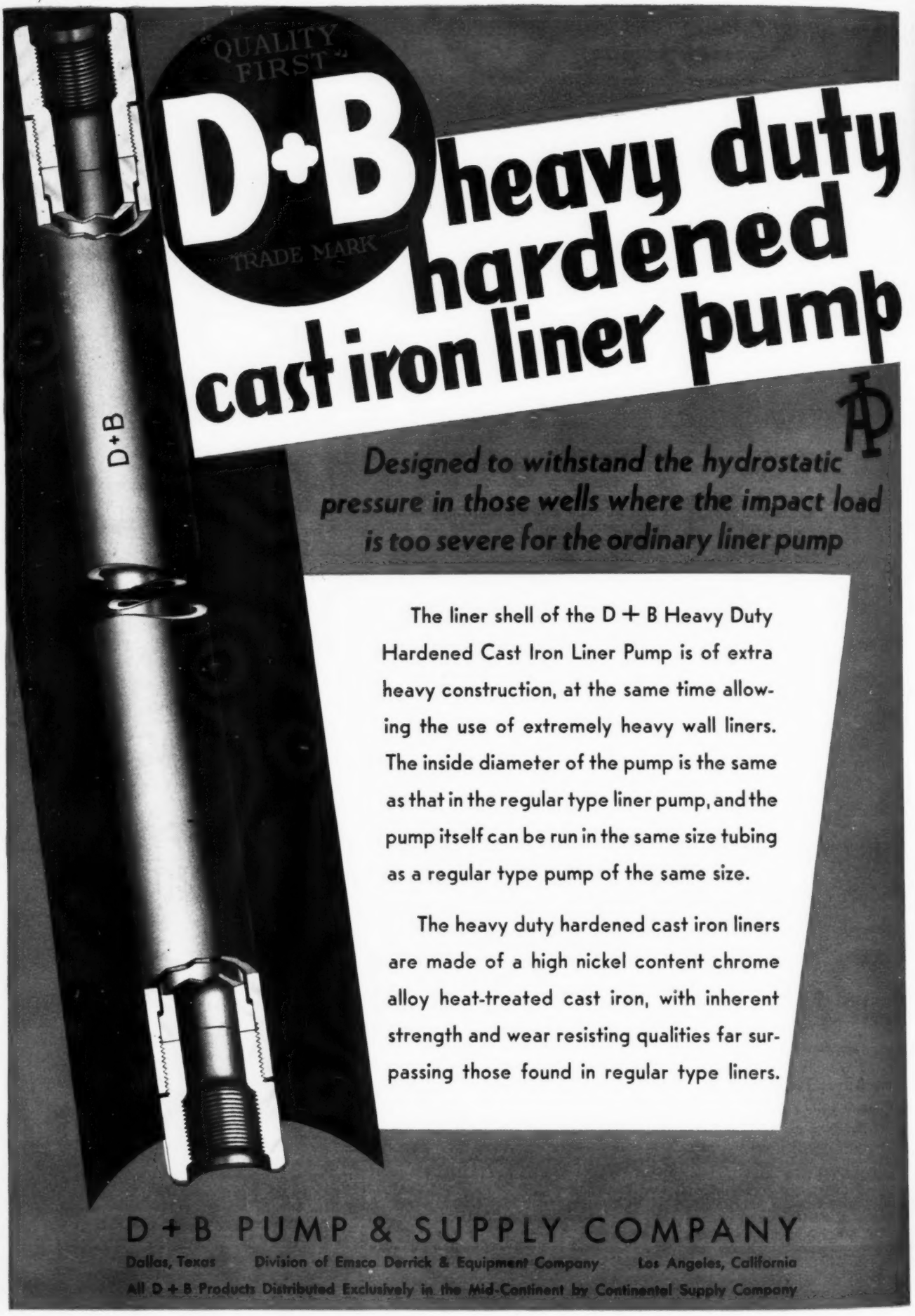
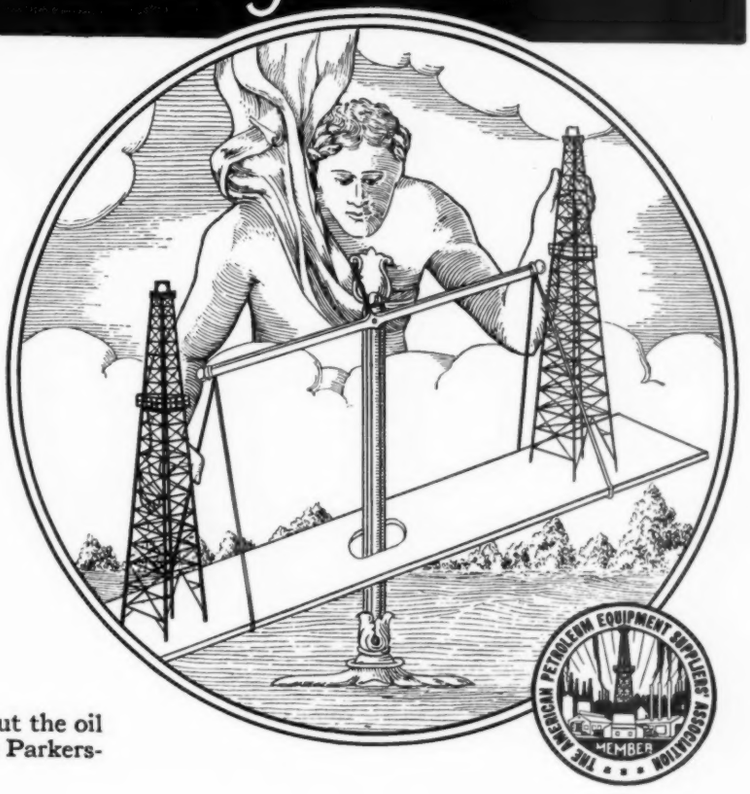

"QUALITY FIRST"
D+B
TRADE MARK
heavy duty hardened cast iron liner pump
D+B
Designed to withstand the hydrostatic pressure in those wells where the impact load is too severe for the ordinary liner pump
The liner shell of the D + B Heavy Duty Hardened Cast Iron Liner Pump is of extra heavy construction, at the same time allowing the use of extremely heavy wall liners. The inside diameter of the pump is the same as that in the regular type liner pump, and the pump itself can be run in the same size tubing as a regular type pump of the same size.
The heavy duty hardened cast iron liners are made of a high nickel content chrome alloy heat-treated cast iron, with inherent strength and wear resisting qualities far surpassing those found in regular type liners.
D + B PUMP & SUPPLY COMPANY
Dallas, Texas Division of Emsco Derrick & Equipment Company Los Angeles, California
All D + B Products Distributed Exclusively in the Mid-Continent by Continental Supply Company

When SAFETY is in the balance, do not compromise with weight!

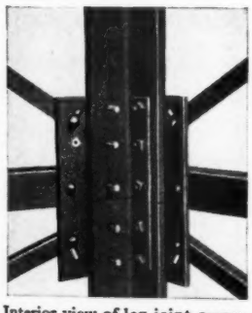


CUTTING corners by lowering the quality of a product to meet a price, has never been a Parkersburg policy. Especially where derricks are concerned, weight has never been sacrificed—with consequent loss of rigidity and safety—in order to win a customer.

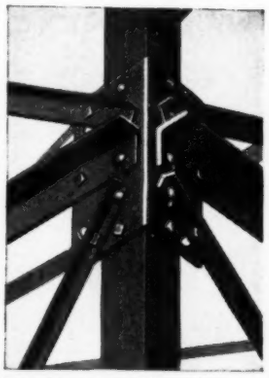
The misrepresentation of a derrick's working load capacity is negligence in its worst form; it is a menace to lives and property and as such will not be countenanced by Parkersburg.

Parkersburg Derricks are made up of steel members of flawless quality, accurately designed to give full strength and rigidity, and are faultlessly fabricated. Only when the *design*, the *steel*, and the *workmanship* are *100% in quality* will the strength, stability and safety of the derrick be assured.

Field records for over 37 years throughout the oil fields of the world attest the worth of this Parkersburg policy.



Interior view of leg joint assembly . . . Note how extra long splice bars reinforce the joint.



Exterior view of leg joint . . . Note large angle splice plate, and slots in girt, brace and leg connections.

BY a simple, basic design Parkersburg secures perfect load distribution without resorting to surplus bracing. This is accomplished by means of butt-to-butt contact of the leg sections, over-size splice plates and patented slot-bolts. Double bolt construction is used in girts and braces on all heavy drilling derricks.

Parkersburg Derricks are as strong as their angle joints . . . and they can be counted upon to carry well over their A.P.I. rated capacities.

Well-organized field forces and near-by stocks of derrick repair parts are further reasons for specifying "Parkersburg."

SERVICE

● A complete Service Organization is maintained at each District office; practical production engineers are always ready to assist producers --- large or small --- in the solution of their problems

THE PARKERSBURG RIG AND REEL CO.

PARKERSBURG, W. VA.

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Stanolind Pipe Line Company's field booster in Fitts Pool, Oklahoma. When this photograph was taken one unit had not been housed in; and the belt guard shown is a temporary one

Pipe Line Facilities Increased For Fitts Pool, Oklahoma — Construction Methods Used

With the Fitts Pool assuming daily added importance, the Stanolind Pipe Line Co. has laid an 8-in. line connecting the pool with its trunk line at Pauls Valley, and the Oklahoma Pipe Line Co. also will serve the area with an 8-in. line.

By
FRANK H. LOVE

IN the Fitts pool of southern Pontotoc County, Oklahoma, one of the most active areas of the state and, according to some authorities, likely to be the next major field, additional pipe line facilities are being provided. The Stanolind Pipe Line Company recently completed an 8-in. line through which crude is now moving, and the Oklahoma Pipe Line Company has under construction a line that is scheduled to be completed by April 1.

When the last potential was taken by the state proration umpire late in January there were 44 deep wells in the Fitts pool, producing from the Hunton and Viola limes and the Wilcox sand. The greatest production is from the latter formation at an approximate average depth of 4300 feet. Average crude tests 38 gravity, is sweet, and requires no treating to meet pipe line requirements.

Previously the only pipe lines serving the area were a 2-in. carrier from the field to a loading rack at Stonewall, and a 4-in. line connecting with the Stanolind's pump station in the Allen pool east of Ada and northeast of the Fitts pool. The new 8-in. line of the Stanolind Pipe Line Company runs westward 40 miles to Pauls Valley, in Garvin County, and there ties into the system's Texas-to-Chicago trunk line. In addition to the 40-mile 8-in. line, the field gathering system is composed of approximately six miles of 8-in., 6-in., and 4-in. pipe. The Oklahoma Pipe Line Company is now constructing a field gravity system, approximately five miles of 6-in. and 8-in. pipe, and an 8-in. line will be laid to transport the crude north to the company's Francis station, a distance of 19 miles.

The Kelly-Dempsey Corporation of Tulsa was the general contractor for the Stanolind line. Thirty working days were required to lay it, considered fast time in view of the nature of the country traversed. Hills, valleys, a sticky gumbo soil, and ten miles of rocky terrain, all contributed to slow up the progress of the ditching machines. The rockiest portion was on the east end of the line, near the Fitts pool. Shooting was required on a total of five miles of the ditch. The ditching machines removed as much of the surface as was possible, and air drills were then employed to assist in placing the charges. When the rock had been shattered by the "shots" manual labor was used to remove it from the trench. The ditch was 20 in. wide and 28 in. deep, providing a 20-in. covering for the pipe. An idea may be gained of the ditching

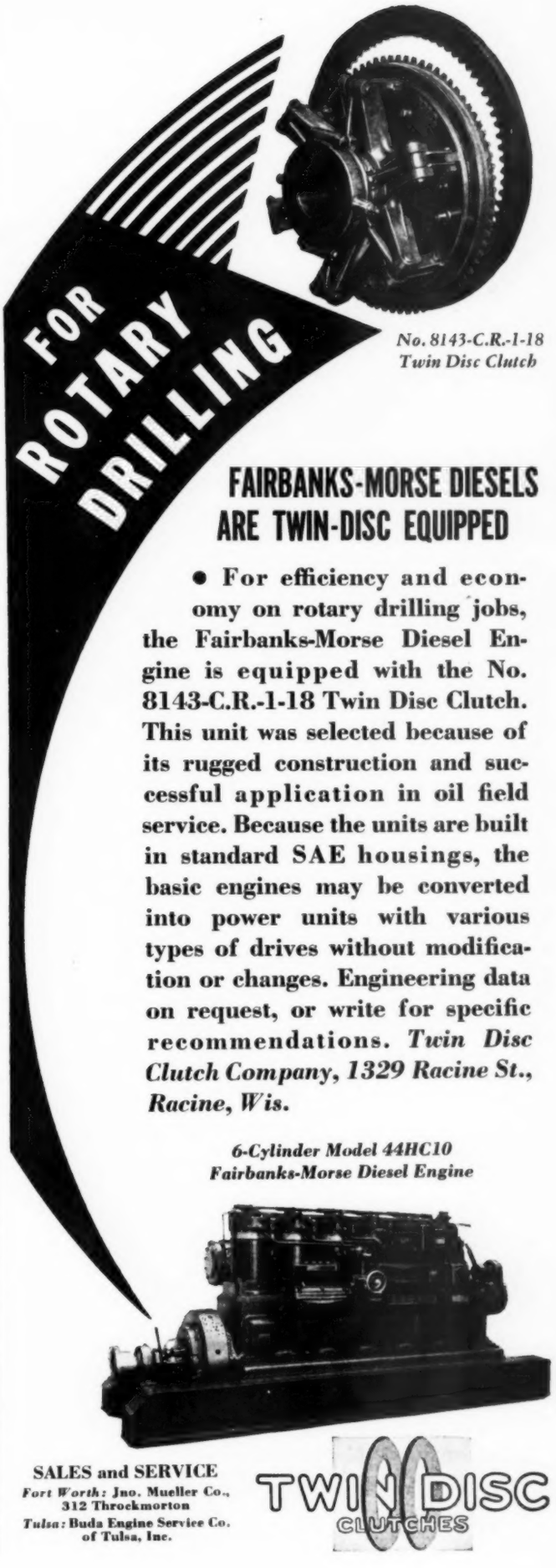
difficulty from the fact that on the best eight-hour day only 5000 ft. was trenched and the average speed fell far below that figure.

The pipe used in constructing the line was reconditioned lap-weld stock taken from various sections of the company's lines. Some of this pipe had been in service over a period of 15 to 18 years. The procedure in the reconditioning process was after couplings and threads had been torch cut and the pipe lifted from the ditch, first to run the sections through a hydraulic straightening machine. This done, the pipe was put through a standard cleaning machine, equipped with rotating steel wire brushes, a sufficient number of times to assure the removal of all dirt and scale. Spot-welding was resorted to where needed, and the pipe was then classified, the best grade being used where line pressures are greatest. Before shipping to destination a priming coat of asphalt paint was applied. The primer was "ragged on" cold and for this work strips of heavy plush rug with wire handles attached were used. Plush is considered an ideal material for the process as the nap is long and retentive of the paint.

The acetylene method of welding was employed, roll welds being used on the joints and bell hole welds for tying in. The firing line crew consisted of eight welders. At times one welder was used for tacking, at other times two, depending upon the length of the joints. All pipe was beveled to 37½ deg. at the time of reconditioning, greatly facilitating the work of the firing line welders. Thus some exceptionally good speeds were made. The average number of roll welds per man per eight-hour day was approximately 50, and the greatest number made by one man in a single day was 54 welds. The greatest number of welds made by the entire crew of eight was 419 in a single day, with the average day's work approximately 400 welds. In the matter of tie-ins, the best day's record was when 11,500 ft. of pipe was tied-in; however, the average was approximately 7,500 feet. The practice followed in testing the welds for leaks was to close the ends and introduce into the pipe a non-corrosive chemical in liquid form, which, upon coming in contact with air, vaporizes. This chemical is extremely odorous and makes the matter of detecting a faulty weld a simple matter.

In laying the line it was necessary to cross one river, the Ouachita, near Pauls Valley. New 32-lb. seamless river pipe was used for this crossing, which was approximately 120 ft. in length. The string was given a specified composite coating and wrapped with asbestos felt, before a second application of the coating was made. Over each weld was placed a 2-in. by 8-in. strap to add strength. Five sets of 8-in. river clamps were used to "weight-down" the pipe. After making up the river string the end was bull-plugged and the whole dragged into position by a tractor equipped with a winch. The pipe was left unburied on the river bed.

Numerous highways and railroads were crossed in the course of constructing the line and in such instances a regulation boring machine was employed. The tunnels thus bored were cased with 10-in. casing and, after the line pipe had been placed in position, the space between the pipe and casing was sealed by Dresser couplings. In each such underpass vents were installed. These consisted of 2-in. pipe, resembling an inverted L, welded into the top-side of the casing and extend-



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TWIN DISC CLUTCHES

ing five ft. above the surface of the ground. The purpose of the vents is to provide an outlet for gas or oil in event of a leak in the line at one of these points, protecting the highway or railroad bed against undermining. Railroad crossings were provided with two vents, one on either side, while highways were given but one.

The testing of the line was accompanied by an interesting method of procedure. In order to save time, 29 miles of line was tied-in, the ends sealed, and air pressure of 100 lb. put on the line. While air pressure was thus being applied, the remaining 11 miles was completed separately. After the 29 miles had been tested the two sections of line were connected by means of a by-pass and the air from the longer section discharged into the shorter. It was found that by employing this method the 11-mile section was given approximately 70 lb. of pressure and air compressors were used to increase that to 100 pounds. The object of this procedure was the conservation of time in applying air pressure, in this instance representing a saving of two days.

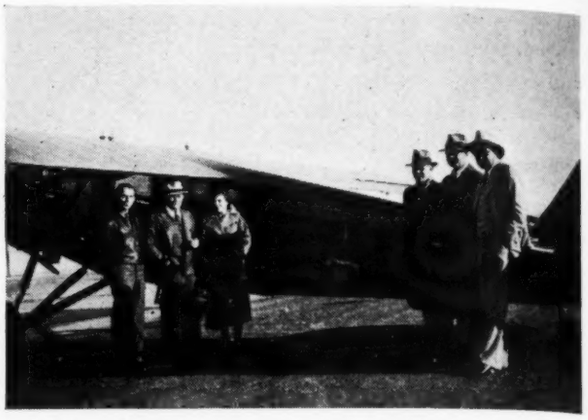
Since the output of crude from the Fitts area is limited, light equipment is used in the Stanolind's field booster station, with heavier units to be installed later if needed. Power units consists of three 50-hp. gas engines driving 5-7 x 10 reciprocating pumps, the entire set-up being capable of pumping 15,000 bbl. daily. The powers and pumps, being hooked up at a 90-deg. angle, form compact units and small buildings amply meet the housing requirements. Each unit is being enclosed in an individual building, 16 ft. in width, 18 ft. in length, and 12 ft. high, and constructed of steel framework covered with corrugated iron. Heavy timbers form the foundations and the steel framework is braced and bolted. Three windows on each side, with two windows and a door on each end, provide ample natural light. Artificial lights are all enclosed in vapor-proof housings. Engines and pumps are set in concrete foundations, and each unit is provided with three sets of instruments: a recording and an indicating instrument for discharge line pressure, and a pressure indicator on the vacuum line. The station is operating at a line pressure of approximately 400 lb. with an average back-pressure on the gravity line of 25 pounds. No working tanks are required, the crude being transferred directly from the gravity line to the discharge line by means of gate valves. Strainers are provided to eliminate foreign matter from the crude before it reaches the pumps. These are placed on the 6-in. suction line between the gravity line and the pumps.

Purchased natural gas is used as fuel for the engines, a 2-in. line connecting to a gas main that runs close to the station site.

The Oklahoma Pipe Line Company's work will be done entirely by its own men. The field gravity system is being constructed now. As mentioned, the gathering system will be of 8-in. and 6-in. pipe, the main discharge line of 8-inch. The pumping unit is to be a 125-hp. gas engine driving a centrifugal pump through gear increasers. The station will be capable of boosting 15,000 bbl. of crude daily, officials of the company state, and operating pressure will be at approximately 300 pounds. Two 30,000-bbl. working tanks will be installed and an 8-10 x 18 suction pump. The station building will be a corrugated-iron structure.

Manufacturers' Representatives to South America by Plane

With the increase in foreign business indicating an extensive application of American oil equipment during the coming year, three California manufacturers of oil tools have recently sent representatives to visit South American fields. The trip is being made by plane with J. W. MacClatchie representing the MacClatchie Manufacturing Company of Compton; S. R. (Pinky) Robinson representing Alexander Anderson, Inc., of Fullerton, and O. P. Yowell Service Company of Los Angeles. Mrs. Robinson will accompany them.



Lef to right: Pilot Leo Root, J. W. MacClatchie, Mrs. S. R. Robinson, Alexander Anderson, S. R. (Pinky) Robinson, and O. P. (Happy) Yowell

The plane, a six-passenger Ryan monoplane, belonging to the MacClatchie Manufacturing Company, left the United Airport at Glendale on January 16. The trip will take from two to three months with the itinerary including stops at El Paso and Brownsville; Tampico and Mexico City in Mexico; Cristobal in the Canal Zone; Bogota in Colombia; Maracaibo in Venezuela; and Port of Spain, Trinidad.

Mike Murphy in California on Business

W. Mike Murphy, Dallas, Texas, Mid-Continent representative of the Air Reduction Sales Company, New York City, is in California on business for his company.

New Service Chart for Nordstrom Valves

The Merco Nordstrom Valve Company, a subsidiary of Pittsburgh Equitable Meter Company, has issued a service chart describing under the headings, "Operation," "Adjustment," "Lubrication" and "Repair," the proper care for Nordstrom Lubricated Plug Valves.

The service chart is printed on heavy stock, suitable for tacking on the wall in operating headquarters or near Nordstrom valve installations. Copies of this chart may be obtained by addressing the main offices of the Merco Nordstrom Valve Company at Pittsburgh, Pennsylvania, or any of their branch offices throughout the country.

S. M. Jones Company Enlarges Field Organization

H. K. Browning, sales manager of the S. M. Jones Company, has moved his family to Tulsa, Oklahoma, where the sales department of the company now occupies enlarged quarters in the McBirney Building.

The field organization of the company is being reorganized and enlarged, it is announced.

Mrs. Estelle Flud, for several years in the Tulsa office, continues in the position of office manager.

THE VITALIZER THAT MAKES THE WINNER

It is often the invisible extra spirit or infinitesimal extra energy that makes the priceless difference between "a race horse" and "a *great* race horse." A similar striking distinction exists between ordinary irons and steels and those into which "Moly" has injected the spark of virility that leads to outstanding qualities for strength, wear, machinability, easy heat-treating, and toughness combined with hardness. Moly really "does something to iron and steel"— many things, in truth. Even more amazing is the fact that so little does so much; and that the slight added cost is repaid over and over in product betterments.

Example: There are many pearlitic steels not containing Moly, which have high physical properties. They even show good strengths at elevated temperatures, if the test is made quickly. But seldom do they hold up over long periods at such temperatures. Accordingly, their "creep strength" is low. Add Moly to such — or *any* — steels, and the "spark of life" introduced results in the retention of strength and form under similar conditions. Results of both experimental and service tests on many different high-temperature applications are yours for the asking.

The developments and applications which have marked Moly's fifteen years of progress would in themselves make a volume of metallurgical history. Investigate. Learn about Moly's widespread uses and acceptance among steel companies, foundries, tool makers, manufacturers of steel-fabricated products. WRITE particularly for these interesting books: "*Molybdenum in* 1934" and "*Molybdenum in Cast Iron* — 1934 *Supplement*." Also ask to be put on the mailing list for our periodical house organ, "*The Moly Matrix*." And, if you've an alloy problem of your own, our metallurgists and experimental laboratory in Detroit will be glad to help you. Climax Molybdenum Company, 500 Fifth Avenue, New York City. (In Canada: Railway & Power Engineering Corp., Ltd.)

CLIMAX Mo-lyb-den-um

"LONG LIFE"

IS ONLY ONE

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Rocky Mountain Distributor: Great Northern Tool & Supply Co.

J. H. Howard Made General Manager Globe Oil Tools Company

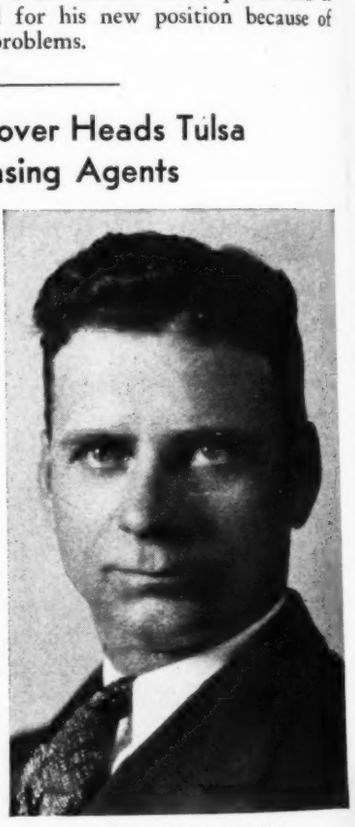
J. H. HOWARD

J. H. Howard has been appointed vice-president and general manager of the Globe Oil Tools Company, Los Nietos, California, to succeed J.C. Wright who resigned recently.

Wright leaves the organization with the best wishes of the officers and directors and of the many friends he has made during the time he has been with the company. It will be the policy of the present management to continue with the same high quality tools and with the same service and operating policies that have been in force since the inception of the company, it is announced.

Howard, formerly production manager of the company, has been connected with Globe since its inception and is particularly well qualified for his new position because of his knowledge of oil field problems.

Howard Stover Heads Tulsa Purchasing Agents



HOWARD F. STOVER

Howard F. Stover, purchasing agent for the Gaso Pump and Burner Manufacturing Company, of Tulsa, Oklahoma, was elected president of the Purchasing Agents' Association of Tulsa at the recent meeting of that body.

Stover is the first purchasing agent for an equipment manufacturing company to hold this office. He has been a member of the association for ten years, has been active in committee work throughout that period, and was successively second vice-president and first vice-president of the organization before being elected as its president.

Other officers elected were H. A. Wilson, purchasing agent of the Superior Oil Corporation, first vice-president; C. M. Taylor, purchasing agent of the I.T.I.O., Bartlesville, second vice-president; M. F. Bridges, purchasing agent Tide Water Oil Company, Tulsa, secretary-treasurer. H. M. Cosgrove is executive secretary, and E. R. Welch, assistant secretary of the association.

Death Takes A. W. Thompson, Well Known Throughout Oil Industry

Friends of Arthur W. Thompson, Bradford, Pennsylvania, well known throughout the oil industry, were grieved

ARTHUR W. THOMPSON

to learn of his death on February 3 following an operation at Johns Hopkins Hospital in Baltimore. He had been in ill health for some time. He was the son of W. P. Thompson, pioneer oil producer, who passed away in 1929.

Thompson was born May 12, 1884, and upon finishing school entered the employ of the Oil Well Supply Company at Bradford, later being sent to the Mid-Continent, with headquarters in Tulsa, Oklahoma. When the Continental Supply Company was founded he went with that organization and was placed in charge of the Pittsburgh office and warehouse. Later he was transferred to St. Louis, Missouri, and made assistant to W. K. Hughes, president of the company. Later he joined the staff of the International Supply Company, returning to Tulsa. His last position in the industry was as Mid-Continent representative of the Westcott Valve Company. In 1929, his father's illness made it necessary for him to sever his Mid-Continent connection and return to Bradford, where he resided until his death.

Surviving are two aunts, Mrs. F. A. Loveland of Crafton, and Mrs. George Lawrence of Oriskany, New York, and several cousins.

SPERRY-SUN WELL SURVEYING CO.

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UNDERGROUND WELL SURVEYING SERVICE

Control Valve Compensation—Thermo Pressure Compensation with dual control of temperature and pressure—Overheat Protector to to prevent damage to thermal system—Separate Recording Coil—Interchangeable Unit Construction—Non-corrosive Materials—and other features insure reliable performance.

Get the most out of your New Solvent Refining Processes with **Mason-Neilan** control

"Give us better oils," insist the oil company sales managers. "Give us better processes," echo the refinery owners. "Give us better control," demand the designing engineers. Today this demand for finer oils is being met by the perfection and introduction of new and improved processes for Solvent Extraction and Dewaxing.

Both here and abroad these new processes are being controlled by Mason-Neilan equipment to insure satisfactory regulation of temperature, flow and pressures, vital to the efficiency of the processes and quality of the products.

Mason-Neilan instruments and regulators have been developed to keep pace with the Oil Industry by trained research engineers. If you are building a new refinery or modernizing an old one — call our nearest representative, an engineer whose specialized experience will be helpful.

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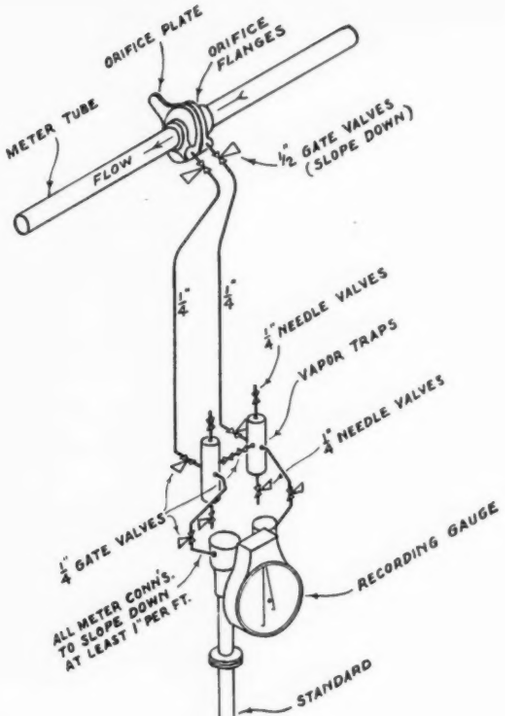


Fig. 1. Gauge piping without seal for measurement of gasoline by orifice meter

Measurement of Natural Gasoline By Meter[1]

By C. D. GARD

Union Oil Company of California

THE gauging of stable liquids in storage tanks held at atmospheric pressure and temperature is relatively simple in procedure and few chances of error exist, therefore, this method of measurement has survived the many technical advancements of the oil industry. However, the measurement of liquefied petroleum products, which includes natural gasoline, requiring the use of pressure storage facilities complicates the gauging. The tendency of these liquids to weather when the pressure is reduced or the temperature is increased causes difficulty in obtaining true gauge column readings. Their volatility makes it practically impossible to obtain the true gravities by withdrawing samples into open containers and may result in the use of improper expansion factors. The presence of small amounts of water in the lower gauge cock connections may interfere with obtaining true liquid levels. The use of large diameter horizontal storage tanks makes it necessary to have these tanks level at all times. Distortion of large tanks has also occurred under certain conditions. The determinations of the correct liquid temperature has always been an item of discussion. The problems of gauging and others equally perplexing have recently been studied by a committee of this organization and recommendations have been made regarding gauging procedure. There still remain, however, a few chances for appreciable errors to occur when measuring volatile petroleum products by tank gauge. In addition, there are disadvantages from an operating standpoint, chief of which is the fire hazard involved in carrying a large storage of volatile liquids in congested or populated areas. We have only to look back over the last few years to be reminded of what disaster may befall any gasoline plant in case of fire or explosion in the vicinity of gasoline storage.

Realizing the disadvantages of the measurement of gasoline in storage tanks and the hazards involved, attempts have been made at various times to devise other means of measuring natural gasoline, such as the application of the orifice meter and more recently the displacement meter.

The orifice meter has proven to be an accurate, economical and very satisfactory method of measuring either stable or unstable gasoline. In many instances, particularly from an operating standpoint, it offers the best solution to many metering problems. It is mostly used in the measurement of gasoline and light petroleum products handled within a single company, such as stabilizer feed, stabilizer product, transfer of gasoline through pipe lines from one department to another, etc. Its use as a means of measuring gasoline deliveries between one company and another is feasible, but as yet its inherent limit of accuracy hardly warrants its use for this purpose, although it often would prove more reliable and accurate than some other forms of tank measurement sometimes practiced.

In using the orifice meter for the measurement of natural gasoline or other petroleum liquids the following data must be obtained:

Orifice diameter.

Internal line diameter.

Temperature of gasoline at orifice conditions, preferably by a recording instrument.

Deg. A.P.I. of gasoline *under* orifice meter *line pressure* corrected to 60 deg. fahrenheit. A continuous record of this variable is needed if flow conditions vary appreciably.

Type of pressure taps used.

Differential record of flow by some reliable recording instrument, and the type of recorder used whether of the mercury or the diaphragm type.

A square root type of chart is recommended, and this would necessitate the knowledge of the differential range of the recording instrument, say 50-in.—100-in., etc.

If some other liquid than the gasoline flowing through the orifice is used as a liquid seal on the differential recorder, then its density in deg. A.P.I. at 60 deg. fahr. should be known.

Time of one revolution of the recording instruments used.

The variables that enter into the routine daily calculations are differential record of flow, temperature of flow and deg. A.P.I. of flowing liquid at 60 deg. fahrenheit. Where greater accuracy is required the temperature and gravity corrections applying to definite time periods of the differential record should be used. However, if flow is somewhat steady and the character of fluid being metered does not change greatly, an average correction for temperature and gravity can be used without much error.

Desirable metering conditions are:

The gasoline must in all instances be under a line pressure greater than its vapor pressure at its line temperature.

The flow rate should be relatively steady.

The differential should not be carried below 3.0, but should average about 6.5 as indicated on a square root chart.

The differential pen should be made to follow the arc correctly in order to determine the time period accurately.

The orifice diameter should be kept between 20 and 75 per cent of internal pipe diameter if flange taps are used;

[1]Paper read before the California Natural Gasoline Association, Dec. 6, 1934.

the upper limit probably should be lowered in the case of line taps.

The meter run should be of ample length to overcome swirls and eddys, this length depending upon valves, regulators, pipe line bends, swedge, etc., prior to and after the orifice. The same recommendations given for gas measurement by American Gas Association, in regard to lengths of meter runs and straightening vanes, are recommended for gasoline measurement.

Pulsation should not exist although apparently the error encountered in liquid measurement is not so great due to this cause as in the case with gases. Centrifugal or rotary type pumps give better flow conditions than the reciprocating type. In some instances, pulsation or surging can be eliminated or reduced by inserting a pulsation deadening chamber with a gas pocket at its top. Gas will have a tendency to go into solution in the gasoline but if contact surface area is small this should be a small item.

In some specific instances it was found necessary to brace the meter run to prevent the vibrations from being carried on to the differential gauge.

Where special orifice fittings are used it is essential that the internal diameter of the meter tube be of the same size as that of the fitting. Van Stone type flanges are preferable in this instance. Gaskets should not protrude into the flow stream.

Special stuffing boxes should be used on the differential recording instruments. Lubricants used should be insoluble in gasoline if no special liquid seals are used.

Methods of checking orifice meter against tank gauges should be provided.

Ordinarily the use of special liquid seals in gauge lines is not recommended, although they should give perfect satisfaction if pots and gauge lines are correctly designed.

When the gasoline flowing through the meter run is allowed to enter gauge and gauge lines the following design has been found to be very satisfactory:

Tap connections should come out at nearly the horizontal center of the pipe. If meter run is above gauge, these connections should slope downward, while if below gauge they should slope upward. Slope should be preferably greater than one in. per foot.

Tap connections should be made by welding ½-in. collars on the line at proper locations and then drilling ¼-in. holes into the line, inserting ½-in. nipples and then installing ½-in. gate valves as close to the meter run as possible. Where special orifice fittings are used these tap connections are usually already installed. To get proper slope to the gauge lines these fittings may be inverted or turned as desired.

The lead lines from the meter run should lead directly to special pots, preferably directly above the recording gauge. There should be no sags or pockets in these lines, for they should slope continually downward from line to pots in the case of a meter run above the gauge or they should slope continually upward from meter run to pots in case the meter run is below gauge.

Very satisfactory pot arrangements are shown in Fig. 1.

These pots should be at the same level. They should have a ¼-in. by-pass line between them containing a ¼-in. gate valve. This by-passing line should be located at about the center of the pots. Pots should have ¼-in. needle valves at their top to bleed off any entrapped vapor and also for flushing out gauge lines. Pots should also have drain valves at their bottoms to drain out any water or dirt and to draw new gasoline into the gauge lines and pots.

The lines to the gauge should take off from about the middle of the pots and slope continually downward and into the gauge itself. Gauge lines of ¼-in. are sufficiently large in most cases.

Usually additional valves are needed on the lead lines and should be placed near pots on line from meter tubs to pots. They should be gate valves.

Vertical or inclined meter runs may be used successfully if flange taps are used, gauge piping being similar to the above recommendations.

The gauge and gauge lines are filled with gasoline from the line in the following manner:

First close all valves on lead lines.

Open both ½-in. gate valves at meter run.

Open by-pass valve.

Gradually open the valve near the pot on *one* of the lead lines.

Gradually open top valves on both pots until gasoline flows out freely and then close these top valves. Differential gauge should then read zero.

Next close by-pass valve.

Open valve near pot on other gauge line that places meter in service.

Thermometer wells should be installed on the downstream side of the meter run at least five, but preferably 12 pipe diameters below the downstream pressure tap. Wells for recording instruments should be used.

Just below the thermometer well, placed in the horizontal center of meter run, a sample cock should be installed. This cock should be connected to a pressure gravity recording apparatus, and may also be used for obtaining a pressure sample of the gasoline for other test purposes. Recording pressure gravitometers are available, and should prove beneficial.

Two valves should be installed, one on each side of the orifice and at the top of the meter run. They should be located at the highest elevation of the meter run or probably about five diameters away from the orifice plate in a truly horizontal meter run. These drain valves are for releasing any gases that might become entrapped in the meter run. It would be beneficial to have other vapor vent valves at other high points in the gasoline line ahead of the orifice meter.

The method of calculating flow recommended is that shown on the data sheets published by the Southern California Meter Association, although other corrections and coefficients published by the various meter companies will probably prove just as satisfactory. Flow has actually been checked quite closely by comparing orifice meter

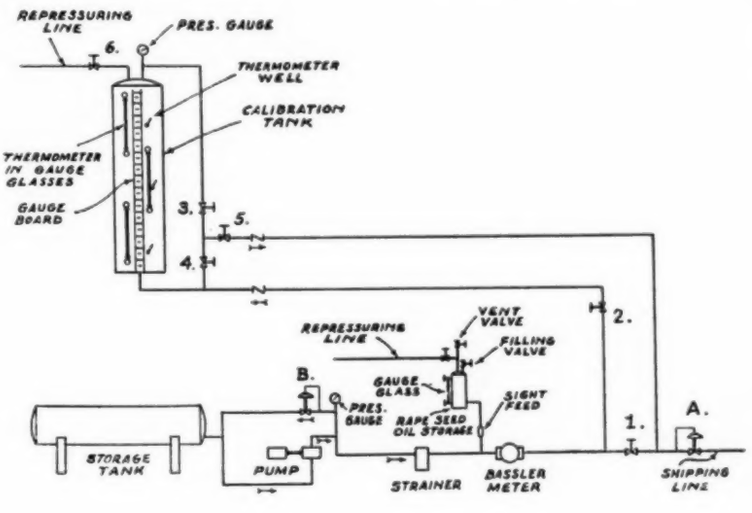
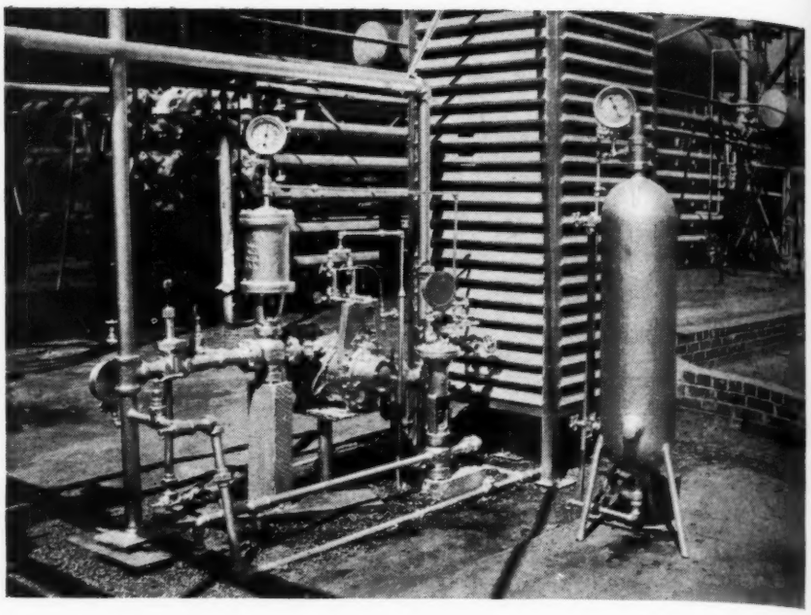


Fig. 2. Use of thermal compensated Bassler gasoline meter for measurement of natural gasoline and its calibration



Typical Bassler gasoline meter hook-up with calibration tank enclosed in a ventilated building

computed volume against actual tank gauges.

The former method of calculation uses the following flow formula:

$Q = (340.0\ C_v d^2) \times T_f \times G_f \times \sqrt{h}$ = gal. per hr., either at 60 deg. fahr. or at flowing temperature, depending upon T_f used.

In the above formula:

C_v = discharge coefficient

d = diameter orifice in inches

T_f = correction for temperature

To obtain volume of flow at 60 deg. fahr. use $T_f = \sqrt{T_c}$, where T_c = volumetric temp. correction.

To obtain volume of flow at line temperature $T_f = \sqrt{1/T_c}$.

Where gasoline under high temperature and pressure is being metered the value of $T_c = \dfrac{1}{(1 + T°F. - 60) \times C_c)}$ has been found to give good results where C_c = the coefficient of expansion for the gasoline metered.

G_f = correction for gravity = $F_g \times S_g$

F_g = the correction for gravity of fluid flowing through the orifice and

$F_g = \sqrt{1/G_{60}}$ where G_{60} = specific gravity gasoline in meter run corrected to 60 deg. fahrenheit.

S_g = the correction for liquid over the mercury in mercury type recording instruments and $S_g = \sqrt{1 - \dfrac{G_{60}}{13.58}}$ assuming the liquid in the gauge is 60 deg. fahrenheit.

Where the gasoline in the gauge is the same as that flowing through the line, G_{60} is the specific gravity of this liquid at 60 deg. fahrenheit. If some other liquid is used for a seal G_{60} would represent the specific gravity of this liquid at 60 deg. fahrenheit.

In diaphragm type gauges $(S_g) = 1.000$.

For mercury gauges using the same liquid in the gauge as that in the line, the combined factor (G_f) is given. Where a sealing fluid is used the factors (F_g) and (S_g) are also given individually.

$\sqrt{h}$ = average of the $\sqrt{}$ differential pressure in in. water for the hour.

Where a square root chart is used

$h = 0.1 \times r \times \sqrt{\text{Max. range gauge in inches of water.}}$

Where r = average of the square root chart reading for the hour.

If temperature and gravity are somewhat constant for the whole day the daily coefficient may be used satisfactorily if square root charts are used and if the average value of r is accurately obtained.

At one gasoline plant raw gasoline from the run-down tanks was delivered to three rectifiers in parallel, an orifice meter being used to measure the gasoline to each of these rectifiers. The gas discharge from the rectifiers was metered by orifice meter while the finished product went to a tank where it was measured. The stable gasoline from the one tank was always being shipped out into a gasoline pipe line while gasoline was filling into the other tank. An orifice meter checking this gasoline shipped out was installed at the discharge of the plant.

Checks on the orifice meters measuring raw gasoline into the rectifiers were roughly done as follows:

Orifice meter measurements of the raw gasoline (at ± 240 deg. fahr. and ± 225 lb. per sq. in. pressure) by the three meters were balanced against the stable gasoline produced and the gasoline equivalent of the waste gas from the rectifiers. These meter runs were five inches.

The results of eleven different tests taken over a period of three months' time with little attention being given to these meters during this interval showed the average error of the orifice meter as plus 0.6 per cent, while the maximum range of variation was between the limits of plus 3.65 per cent to minus 1.22 per cent. As numerous items could affect this method of checking such as variations in liquid levels of rectifiers, incorrect waste gas measurements, etc., this variation appears quite satisfactory considering the temperature of the gasoline being metered.

Checks on the gasoline meter measuring the finished product against tank gauges were as follows:

Test Period Days	Gallons at 60 deg. fahr. by: Tank Gauges	Orifice	Diff.	Per Cent Diff.	Max. Variation Per Cent
26	2,949,607	2,949,287	— 320	—0.011	+3.05 to —3.71
13	1,254,746	1,249,170	—5576	—0.44	+2.39 to —2.69
6	587,582	585,962	—1620	—0.28	+1.48 to —1.40
17	1,670,350	1,644,066	—26284	—1.57*	—0.31 to —3.07
9	790,742	783,706	—7036	—0.89	—0.21 to —2.29
10	728,000	721,744	—6256	—0.86*	—0.13 to —1.08
11 special tests over 3-months' period	122,903	122,434	— 469	—0.38	+0.81 to —1.13

*Denotes periods of excessive line and gauge vibration as well as fluid pulsation in meter run.

All the above data were obtained by means of routine plant and office procedure with the exception of the eleven special tests where greater care was taken.

Later tests were made using a carefully constructed elevated 4-in. meter run. Gauge pots and piping were made as shown in the diagram.

Both stable gasoline and cold raw gasoline were metered successfully through this meter for over a year's time. Numerous check tests on this meter showed an inherent error of about minus 1.0 per cent as compared to tank gauges, the error varying from about 0.0 to 2.0 per cent. By applying a straight connection factor of about plus 1 per cent to this meter, the flow could be determined accurately within ± 1.0 per cent. This factor might change for different installations and would have to be determined experimentally. Although a great deal of care was taken to see that the meter was kept in good working order, and occasional routine check tests of the orifice against tank gauges were made, the

Calibration tank for gasoline meter hook-up, shown in its ventilated shelter

orifice meter method proved far more satisfactory than the method of tank gauging as formerly used. This orifice meter was used as the official measurement of this plant's production for over a year's time.

The advantages of the orifice meter over tank gauges for measurements of natural gasoline are: A continuous record of the rate of flow, saving in time required by operator for dispatching gasoline, possible saving in pumping costs, reduces fire hazard by carrying minimum storage in plant yard, is very economical and safe. Any error of measurement is automatically limited to one source, that is the accuracy of the meter.

The disadvantages are, the accuracy of the measurement can be not more than the accuracy of the meter. Ideal metering conditions must exist to obtain reliable results. Pulsating flow is detrimental to good measurement and is often impossible to eliminate.

The orifice meter computations require temperature and pressure gravity determinations and corrections that when combined with the accurate reading of the differential becomes somewhat of a tedious job.

The orifice meter should be checked against tank measurements at routine intervals and the gauge should be checked to zero and the pots blown out regularly.

The orifice meter is well adapted for use in measuring gasoline within a refinery or natural gasoline plant where small errors are not of serious consequence.

In many instances where rate of flow must be known accurately they are indispensable. It is obvious that orifice meters should give results more reliable than doubtful tank gauges. Where orifice meters are installed the differential recording gauge should be made to face the control valve wherever possible.

The use of displacement meters for the measurement of petroleum oils has met with only moderate success until the past few years.

One manufacturer, the American Liquid Meter Company of Alhambra, California, has developed such a meter. It is patterned after their oil and motor gasoline meters, which have made quite a name for themselves, and is known as the Bassler meter in honor of its inventor, Mr. Bassler. This natural gasoline meter is the result of considerable research and experimental work and the normal operating accuracy

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of this meter indicates how thoroughly this work has been done. Besides the accurate measurement of the gasoline passed through the meter, the volume of the gasoline is automatically corrected to 60 deg. fahr. by an ingenious temperature compensator, which is an exclusive feature of this meter.

The Thermal Compensated Bassler gasoline meter for the measurement of natural gasoline has been in use by the Union Oil Company of California for the past three years. Four of these meters have been in use during this time, measuring gasoline shipped to the pipe line from storage tanks at the production rate, only sufficient gasoline being held in storage to obtain a continuous flow of gasoline through the meter. It was originally expected that these meters would hold their calibration within 0.5 per cent between check periods. A recent six-months' check of these meters showed the arithmetic average error to be 0.06 per cent on three meters and 0.20 per cent on the fourth; with a maximum observed error of less than 1.0 per cent on any meter. One of these meters, an 1½-in. size, passed approximately 30 million gal. before an overhaul was necessary. The other meters handled proportionate amounts.

It was found that these meters will run entirely satisfactory without any lubrication when measuring some stable gasolines. However, when metering wild gasoline it was found necessary to inject a small amount of special lubricant into the inlet of the meter. The type of lubrication found to be most satisfactory is blown Rape seed oil with a viscosity of 800 Saybolt seconds at 200 deg. fahrenheit. It is important to keep this oil flowing continuously into the inlet stream to the meter at a uniform rate. The quantity of oil required is approximately one quart for each 12,000 gal. of gasoline metered or about one part oil to 50,000 parts of gasoline.

The oil may be injected by the use of a pump lubricator or by feeding the oil from a pressure storage tank and through a sight feed lubricator into the meter. As the viscosity of Rape seed oil increases rapidly when exposed to the air it is advisable to avoid unnecessary exposing of the oil to air.

In measuring volatile liquids it is necessary to avoid reduction of the pressure on the liquid while passing through the meter. That is, the metering pressure should always be higher than the vapor pressure of the liquid. This may be accomplished by increasing the static head on the meter above the storage pressure of the liquid being metered to offset any loss of pressure through meter and lines. The tanks may be elevated or the meter located below the outlet of tanks sufficiently to obtain the desired results. Where the meter is placed on the discharge of a pump, it is advisable to hold a uniform pressure on the meter by use of a back pressure valve. In this case it is necessary also to use a relief valve on the intake to the meter to protect the meter against excessive pump pressures. This relief valve may be vented back to the suction of the pump or to the storage tank.

The advantages of this meter over the gauging of storage tanks are: (1) reduction of gasoline carried in absorption plant yard storage, as only one tank is required and the level in this tank may be held at the minimum required to give satisfactory operation of the meter; (2) reduction of fire hazard due to small storage on hand; (3) provides constant check on operation of plant; (4) gives corrected gallons at 60 deg. fahr., thus reducing clerical work; (5) provides a more accurate method of gauging, as the limit of error is much smaller than when using storage tanks and gauge boards or orifice meters; (6) periodic calibrations of the meter provide a check on the accuracy of measurements. It must be remembered that the Bassler meter unit is gallons, while the tank gauge unit is inches of liquid and the orifice meter inches of differential.

A suggested metering arrangement is outlined by the diagram.

All valves are closed except "1." Back pressure valve "A" is set to give the desired pressure on the meter. Back pressure (relief) valve "B" is set at the maximum pressure to be carried on the meter. Lubrication is continuously supplied at a uniform rate through sight feed lubricator. Sufficient pressure (preferably natural gas) is kept on the Rape seed oil storage tank to establish flow.

I—Purging of Calibration Tank.

This is desirable to bring the temperature of the tank to the flowing temperature of the gasoline. This procedure insures a more uniform checking. This tank may be insulated if desired.

With valves "6" and "4" closed, open valves "2," "3" and "5," close valve "1."

II—Empty Calibration Tank.

When the reading on the thermometers located in the thermometer wells of the tank become constant, flow is shut off and the tank emptied to a low gauge. With valve "5" open, open valves "1" and "4," close valves "2" and "3," open valve "6," allowing sufficient gas to enter tank to flow gasoline from tank. When liquid has reached low gauge close valves "4" and "6."

III—Gauging Calibration Tank.

Purge lower gauge glass until thermometer in glass reads constant temperature. Note temperature and liquid level. Check for leaks by observing level. Close valve "1" and read meter. Open valves "3" and "2" and fill tank to high gauge. Close valve "2," read meter, record reading and open valve "1." Note temperature in upper gauge glass and purge glass repeatedly until thermometer reads constant temperature. Read high gauge and temperature and record.

The reading of the high and low gauges are corrected to 60 deg. fahr. temperature and the net difference recorded. This difference is then compared with the metered difference. If the meter is in error a check reading may be made by repeating the procedure. The meter may be adjusted by closing valves on the intake and discharge pipes of the meter, draining the meter of liquid, removing a plug in the meter case and turning the adjusting screw.

In order to facilitate the calibration of the meter it is suggested the calibration tank be of 100 gallons capacity.

The frequency of checks will depend upon the desired accuracy wanted. It has been found that by checking these meters once each week we have eliminated any appreciable error. Frequently our weekly checks show no error in the meter or will show the same error as the previous test. As a rule no attempt has been made to adjust the meters unless the error was greater than 0.5 per cent.

The two photographs illustrate a typical Bassler gasoline meter hook-up with the calibration tank enclosed in a ventilated building.

New Catalog Chaplin-Fulton Manufacturing Company

A somewhat enlarged but nevertheless compact and manageable 1935 catalog of the Chaplin-Fulton Manufacturing Company, Pittsburgh, Pennsylvania, just issued, is dedicated to those responsible "for the safe and economical distribution and regulation of natural and manufactured gas in private dwellings, mills, factories, and street mains and for the controlling of the steam pressure and gas fuel supply to steam boilers." The catalog is well printed, illustrated, and provided with charts and tables. The types of regulators described and shown cover all the more common forms of service for both natural and manufactured gas, and the availability of special regulators for many special purposes in the use of steam, water, oil and air is made plain.

D. M. McCargar Promoted

D. M. McCargar has been made district manager by the Allis-Chalmers Manufacturing Company of their newly-created Oklahoma-Arkansas district. Formerly the Tulsa office was maintained as a branch with McCargar in charge. He will continue to make his headquarters in Tulsa, Oklahoma.

Harry E. Miles Succeeds Captain Stanley

Harry E. Miles has succeeded Captain E. N. Stanley, resigned, as chief engineer of the Texas Railroad Commission in charge of enforcement in the East Texas field. Miles has been Stanley's assistant. The appointment was effective February 1.

Export Sales Agents for McNeely Mud Screen Named

Export sales of the McNeely Vibrating Mud Screen will be handled by The National Supply Corporation and the Oil Well Supply Company, according to an announcement by Harry H. Isaacs, president of Vernon Tool Company, Ltd., Los Angeles. The McNeely Screen, manufactured by the latter firm, has met with marked success in the service of many of the largest domestic operators for the conditioning and reclaiming of drilling fluids. The National and Oil Well have available bulletins descriptive of the McNeely Screen for distribution to operators in the foreign, and also domestic, fields who are interested in the savings and benefits derived from mud screening.

Allis-Chalmers Holds Open House

Displaying a diversified line of equipment the Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, was host at "open house" recently to more than 30,000. For the first time the huge plant covering 155 acres was opened to families of employees and other guests. Officials pronounced the get-acquainted party a great success.

At the invitation of Chairman Otto H. Falk and President Max W. Babb, thousands filed through three miles of shops and foundries for a glimpse at the huge 115,000 hp. turbines under construction for Boulder Dam and to see other industrial wonders. Employees and their families totaling 18,000 were guests during the forenoon.

New Struthers-Wells Address

Since February 9th, the Chicago office of the Struthers-Wells Company, manufacturers of chemical process equipment, has been located in the People's Gas Building, 122 South Michigan Avenue.

E. W. Bixby Now with Pittsburgh Equitable

The Pittsburgh Equitable Meter Company, Pittsburgh, Pennsylvania, announces that E. W. Bixby has joined their organization in a sales capacity. Bixby, who will be attached to the recently opened Memphis office of this company at 67 McCall Street, is well known to the trade throughout the South. He was formerly sales manager for the Columbian Iron Works at Chattanooga, Tennessee.

He will represent both the Pittsburgh Equitable Meter Company and its subsidiary organization, the Merco Nordstrom Valve Company.

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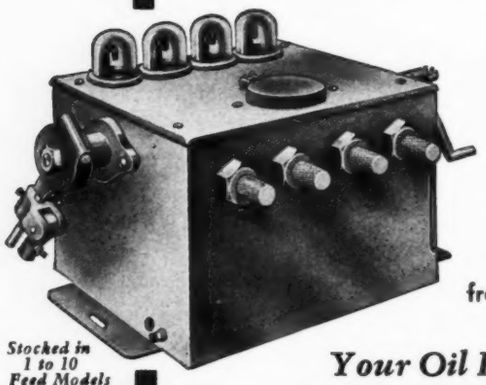

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